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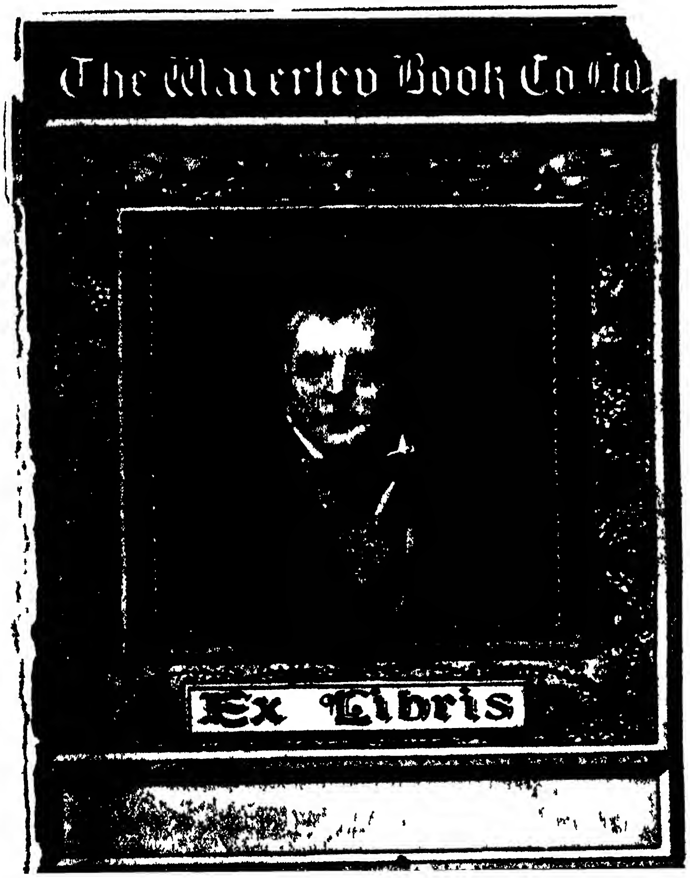
WONDERS OF ANIMAL LIFE



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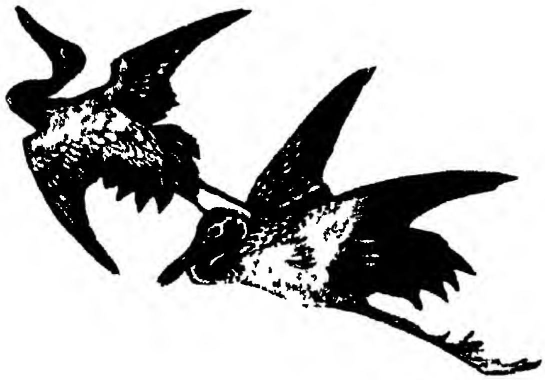
WONDERS OF ANIMAL LIFE

By Famous Writers on Natural History

Edited by
J. A. HAMMERTON

Over Three Thousand Illustrations from Photographs and Thirty-three Colour Plates

FIRST VOLUME
Pages 1-456



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WONDERS OF ANIMAL LIFE

A Foreword by the Editor

HERE is not a 'natural history' in the accepted meaning of that description. There exist many and excellent natural histories and more than fifteen years ago the present editor was associated with the publication of one which, in its authoritative letterpress and profuse illustration, had wide acceptance. But it is undeniable that the general reader finds large and exhaustive treatises on animal life, encumbered with Latin names, somewhat hard reading, however fine their illustrations, if they are arranged on the approved scientific divisions—order, family, genus, species—into which naturalists split up animated nature. A proper natural history, however, must follow this method of treatment if it is to form the basis of a scientific knowledge of the subject.

Does the ordinary reader desire such a knowledge? Does he require it?

The answer to both questions is a negative: emphatic in the first and modified in the second case. No matter how slightly youth is drawn to the conventional study of zoology, not even the forbidding scientific approach to natural history can rob it of its inherent fascination.

A BOUNDLESS curiosity about the infinite diversity of creatures that share the life of the globe with him is a deep and abiding and a most natural trait in man. The stories of Adam naming the beasts, and of the animals, two by two, going into the ark are ancient evidence of man's interest in his fellow-creatures of the so-called lower orders. A study of the life-histories of many animals and birds, fishes and reptiles, or of the astounding social systems of certain insects, is calculated to limit man's pride in himself as the incarnation of the highest intelligence or the finest physical product of the animal world. Especially is it likely to extend his sympathy to all lowly things that are living out their little days with him upon this planet. It lies at the root of humanitarianism. Interest in animal life is never an idle curiosity, and it may prove more absorbing than any other interest that could be named.

Not, then, to add a new natural history to a list already adequate, but to meet this universal and most healthy interest in the astonishing realities and the mysterious ways of the animal kingdom is the purpose of WONDERS OF ANIMAL LIFE. Its title adequately suggests its scope: to enquire into and to illustrate all that is of uncommon interest in the life of the animal kingdom.

WHILE the reader will find in our pages a constantly changing panorama of animal life, with no more apparent order than the naturalist finds in the Brazilian jungle, he can hardly fail to be interested and he is certain to be instructed, for though the only method that is observed throughout our chapters is a rough alternation of interest, now in mammals, next in reptiles, then in birds, fishes, insects, each chapter of this work is written either by one of the leading specialists on his subject or—where expert knowledge is less needed than vividness of descriptive style—by a popular author.

A glance at the list of contributors, their scientific and literary credentials, and the subjects allotted to them in our scheme, will indicate to the reader that though WONDERS OF ANIMAL LIFE is designedly popular in its appeal, it is not the less authoritative in being more entertaining than the conventional sort of natural history.

NEVER before has there been brought together so representative and so varied a collection of photographic documents covering the whole range of animated nature. In the last decade, and particularly within the latter part of it, naturalists have acquired an immense amount of new knowledge, and marked progress has been made in recording the wild life of the world by means of direct photography.

The exploits of the camera experts employed by the organizers of some of the great 'nature and adventure' films—'Simba' is a fine example—that have fascinated millions throughout the world in these years have produced so rich a body of material for illustrating such a work as this that editorially we are in a more favoured position than any of our predecessors in the same field and we hope the reader will agree with us in thinking that we have taken advantage of that fortunate circumstance for his entertainment and instruction.

J. A. HAMMERTON

Neville Kingston

THE CHIMPANZEE AND ITS STRANGE PLAYMATES

The chimpanzee is a playful little fellow and loves a game. If he can have another chimpanzee as a companion he is perfectly happy and his life is as jolly as that of a schoolboy. But if he has no chimpanzee mate he will make friends with other animals and some strange companionships are the result. The upper picture shows a chimpanzee kissing a rock-python with whom he plays quite fearlessly, and in the lower photograph we see a chimpanzee at the London Zoological Gardens playing with a rat, which he is said to treat with great tenderness.

Chapter I

Man's Nearest Kin in the Animal World

By Professor Sir Arthur Keith, F.R.S.

President of the British Association 1927-28; Author of "The Antiquity of Man."

So vast has the number of known animals become and so diverse are they in structure and nature that the editor of a modern work such as this has now to employ an army of specialists.

It was not so 200 years ago; in 1735 a young Swedish naturalist named Carl Linné, or Linneus, enumerated all the living things then known, both plants and animals, gave them names, and arranged them in Orders or main groups. To the highest or first Order of animals he gave the name Primates, animals with teeth which were arranged according to a stated formula and with only one pair of breasts, set upon the chest, not on the flanks. As Man answered to these criteria Linneus gave him the highest place amongst the Primates.

The second place in this Order he gave to a group or genus which he named Simia. It was in this group, which is now to engage our attention, that he placed apes and monkeys. The third and fourth groups or kinds of animals which Linneus included among the Primates, the lemurs and the bats, do not concern us here.

In the middle part of the eighteenth century, when Linneus was issuing edition after edition of his System of Nature, the twelfth and last edition of which appeared in 1766, large parts of the earth were still unknown. Only the fringe of the great African continent had been charted, a continent three times the size of Europe, and the modern headquarters of the Simian world. The jungles of the distant East, of Borneo, Sumatra, and Farther India, representing a combined area equal to a third of Europe, the home of so many interesting Simian forms, were unexplored. The immense forests of South America had not yet revealed their secrets. All that was then known in Europe of the apes and monkeys of these distant lands were such specimens as sailors secured in the course of their voyages and such tales as travellers gathered from coastal natives and recounted on their return home.

F. W. Bond

CLOTHES MAKE THE APE MORE MAN-LIKE

When man-like apes are dressed in human garb, like this chimpanzee, even those who doubt the theory of evolution will not deny the suggestion of human kinship in their appearance

Linneus was an earnest seeker after truth, but found it hard to separate fact from fiction in the publications of his time. When so much of the earth was still unknown every fabulous thing was still possible. Among the races of mankind Linneus accepted, in all seriousness, the existence of *Homo caudatus*, tailed men, of *Troglodyta bontii*, hairy men, and of two other mythical human races.

But, having now searched the earth, we can say with complete confidence that the monstrous forms of humanity in which our forefathers believed have no existence in reality and that all living races of mankind, much as they differ in appearance and in habit, are yet members of a single species, for we know that children may be born to parents who represent the most diverse of living racial stocks. Yet the world of humanity was not always thus; we know, from the geological records, that in past times the earth was inhabited by races so diverse in structure and nature that we must ascribe them to separate species and even to separate genera.

Before diving into the Simian world as we know it to-day we must consider for a moment what Linneus knew of apes and monkeys. He made three divisions, the first included those which had no outward trace of a tail; the second, those which had short tails; the third, those which had long tails; a scheme which had at least the merit of simplicity. When we remember that the Manx cat is tailless, and yet is none the less a cat, and that tailless breeds of dogs and of fowls are known, it may be thought that Linneus was much at fault in selecting such a structure as the tail as a basis for classification. As a matter of fact modern inquiry has proved that when Linneus grouped together the tailless apes he showed real insight, for the absence of a tail is an outward sign of a profound change which has affected all parts of the inward body. The tailless apes of Linneus are the man-like, or anthropoid, apes of our scientific classification of to-day.

THE BIGGEST GORILLA EVER SEEN BY MAN

The enormous size of the adult gorilla can be easily appreciated in this photograph of a specimen shot in the Cameroon forest It is said to be the largest gorilla ever seen by man and was seven feet high, while its weight was about a fifth of a ton Of all the great anthropoids the gorilla has its lower limbs best developed, and in its leg is often found a certain muscle which is also present in the leg of man but not in that of any other animal The gorilla's footprint is three times the size of that of a full-grown man

The jungles of the Old World and of the New have now been explored, superficially at least, and we are convinced that of the many kinds of anthropoid, or tailless, apes which lived in past geological times, only four now survive Two of these live in Africa, the gorilla and chimpanzee, a third, the orang-utan, inhabits Borneo and Sumatra, the fourth, the gibbon, lives in the forests of Farther India, and of the islands of Hainan, Borneo, Celebes, Java, and Sumatra

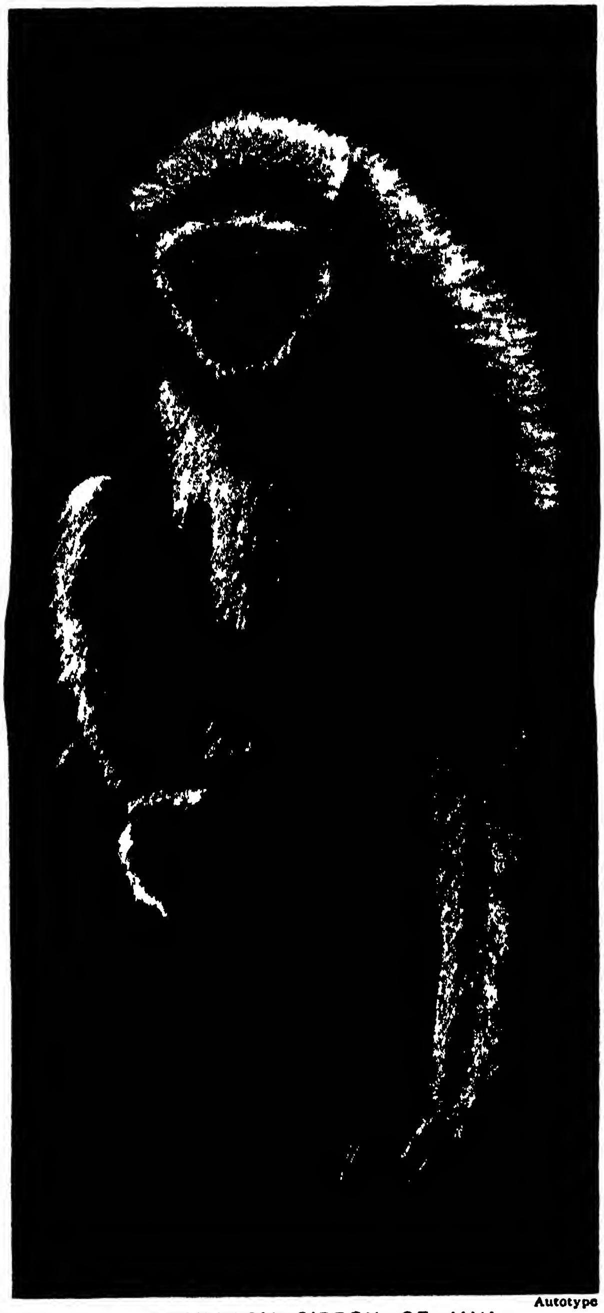
Time has justified Linneus in placing man at the head of the Order Primates, and in brigading certain apes together just because they were destitute of an outward tail. To an inexperienced onlooker it may seem equally hazardous when we of to-day employ a character so variable as size of body as a means of separating the tailless, or anthropoid, apes into two categories, the small anthropoids and the great.

THE GORILLA AS HE FACES AN ENEMY IN THE STEAMING AFRICAN FOREST

The gorilla will stand up in this way to face a foe although his usual attitude when moving about is on all fours. In muscular development he vastly surpasses the most powerful human prize-fighter. So bulky does he become in adult life that he finds himself unable to climb the trees as the females and younger members of his family can At night he sleeps by the foot of the tree in whose boughs his family is safely bestowed. No full-grown male has been photographed alive, and this picture is from a stuffed specimen.

Everyone knows how the dog, horse, and ox may vary in size of body, and yet, great or small, they are still dogs, horses, and oxen. A dwarf or pigmy is none the less human because he is small. Yet the fact remains without question that size of body, among the Primates, is linked to hundreds of changes in structural organization.

Geological records reveal the earliest Primates as small animals, no bigger than rats or squirrels; we do not encounter larger forms until we have followed primate evolution at least half-way along its geological history. The gibbon, we now know, represents an ancient type, and is a small anthropoid varying from fourteen pounds to twenty-eight pounds, that is, from one to two stones. On the other hand, the chimpanzee, gorilla, and orang are great anthropoids. In size of body they are human or ultra-human, varying in weight from eight or twelve



Autotype

THE SILVERY GIBBON OF JAVA

Curiously enough, the gibbons, although the lowest and smallest of the man like apes, are the only ones that habitually walk in an upright position. Their arms are so long that they touch the ground when walking upright. They are very affectionate creatures.

stones among chimpanzees to twelve or thirty stones among gorillas. And their weight is due not to the accumulation of fat, but of solid bone, muscle, and viscera. In size of body, as well as in many details of structure, man agrees with the great anthropoids; anthropologists often find it convenient to have a name for this big-bodied group, and speak of its members as the Great Primates.

I have introduced the reader to the most recent conception of the animals whose lives I am to sketch. But how we have blundered as we reached forward to come by it! To illustrate our initial mistakes let us suppose for a moment that the mastery of the world had fallen not to strong-legged man but to the arboreal chimpanzee, and that in the course of marauding expeditions along our coasts chimpanzee sailors had captured stray waifs here and there and carried them away home to their African headquarters.

There the unhappy children are encaged in a treetop and the chimpanzee public crowds round to gaze at them with curious eyes. We can see the learned professor of the jungle step forward and explain to his interested audience what poor, weak, helpless, and ignorant beings these human captives are. Compared with themselves, how ill adapted such anomalous beings are for all the purposes of arboreal life. Just look at their feet! Could anyone conceive structures more awkwardly fashioned for the purposes of climbing, or hands and arms more useless for a life in the jungle? It puzzles this learned chimpanzee to know why Nature should ever have made such weaklings, for he supposes that the captives before him are adults.

Now it is after this manner that men made their acquaintance with the great anthropoids. In the time of Linneus naturalists had only an occasional opportunity of seeing an anthropoid waif captured on the coast of Africa or of Borneo, and strange to say they confused the one with the other, for the Malay name orang-utan, or man of the woods, was given indiscriminately to both orang and chimpanzee. It was not until about the middle of the 19th century, when trained naturalists such as Russel Wallace, or adventurous explorers like Du Chaillu, began to penetrate the tropical jungles of the East and of Africa and observe anthropoid life in its native setting, that we began to realize the number and extent of our original misconceptions.

Our knowledge of the gorilla began in 1847. In that year Dr. Savage, an American medical missionary in the French Gaboon, made its existence known to the world. Our pioneer explorers had to make the acquaintance of anthropoid apes gun in hand; in no other way could they come by the knowledge we all desired. The harsher methods of the early pioneers are now being replaced by more gentle and more profitable modes of inquiry. When our modern explorers bring their harvests home we shall understand the simian world better than our forefathers did.

I do not, of course, undervalue the knowledge which has been gained by those who have studied the apes in captivity. It was thus that Darwin became acquainted with their modes of expression and behaviour. Sally, an accomplished and intelligent chimpanzee which lived eight years in the Zoological Gardens, London, some forty years ago, had her mental gifts measured and registered by Dr. G. J. Romanes. In more recent years trained psychologists have built laboratories for the study of anthropoid apes and monkeys, such

studies being carried out over periods of months and even years. Just before the Great War the Germans established such a laboratory in the Island of Teneriffe. Dr. Köhler, Professor of Philosophy in the University of Berlin, has summed up what he learned while in charge of that laboratory in a book called "The Mentality of Apes."

THE most painstaking and illuminating researches so far made are those of the American psychologist, Dr. Robert M. Yerkes, who has published his studies on the mentality of gorillas and chimpanzees, orangs and monkeys in many recent monographs and books. In intelligence he places the chimpanzee first, the orang second, the gorilla third, but has some doubt as to the real place of the gorilla, as that animal is naturally undemonstrative and seems to possess an ability which it declines to exhibit.

We learn from the experience of Dr. Yerkes that the first requisite for an experimenter is to place himself on the best terms possible with the subject of his inquiry. He must wait patiently hours or days for requisite opportunities. He found that individual apes vary as much in their intelligence as do men and women; their moods change from hour to hour and from day to day. Their minds react according to their state of health. To set their minds working there must be an incentive, and the mental stimulus on which every experimenter depends is that of food. To ascertain the mental resources of apes, psychologists have devised an infinite variety of food-finding problems, bananas suspended so high that they can be reached only by placing boxes upon one another, or placed so far outside the cage bars that they can be reached only by the aid of a stick. Some anthropoids have solved these problems unaided, but the majority require tuition or example, and to be trained they have to be taken in hand during childhood; adults stubbornly refuse to learn. In all of these points anthropoid apes may be described as human.

I made the acquaintance of apes as a young medical man in the jungles of the East some forty years ago. I dissected examples to discover whether or not they suffered from malaria, which plagued us poor humans. In the course of long journeys through the primeval forest I observed how the families or small bands of gibbons which abounded in those parts differed from ordinary apes. Ordinary or dog-like monkeys run along branches on all fours. When they plunge heavily from tree to tree they use their hinder limbs as the impelling power. The gibbon, on the other hand, ran along branches with its body upright, supporting itself upright on its lower limbs and using its arms lightly on branches overhead. Then, when it leapt from tree to tree (and I have seen it clear an open space of forty feet), it derived its impetus, like a gymnast, from the

F. W. Bond

YOUNG GORILLA THAT LIVED IN LONDON FOR SOME YEARS

It used to be thought that gorillas could not be kept in captivity, but this one, known to his friends as John Daniel, lived in a London house and used to travel about the town. At night he slept in an ordinary bed, and his meals were taken at table with knife, fork, and spoon just as though he were human. After being parted from his mistress, he died of a broken heart

swing of the arms. Its arms are particularly long; the biceps and neighbouring muscles of the arm are strong and highly specialised, and its long, narrow hands serve as flexible hooks.

Ordinary monkeys—there were families of macaques as well as of semnopithecques in the district—were pronograde, or horizontal, in their posture of body and mode of climbing, whereas the gibbon was orthograde, or upright, in his carriage. I soon found that this mode of holding the body was reflected in every detail of the gibbon's anatomy—in the muscles of the back, in the arrangement of heart, lungs, and viscera, and in every joint and bone of its body. And in all, or nearly all of these orthograde adaptations, he resembled man. And yet in size, in the soft fur of his body, in the callosities on which he sits and sleeps, even in the volume of his brain, he differed little from the ordinary dog-like, or cynomorphous, monkey. Somehow the assumption or evolution of the orthograde posture had brought about the complete disappearance of the tail and a radical transformation of the muscles which, in pronograde apes, move the basal part of the tail.

It was then that I began to realize that posture has played an exceedingly important part in the evolution of the primates—that it was a fundamental character. At first I supposed that the gibbon was merely an ordinary type of monkey which had taken to climbing in an orthograde, hand-over-hand way, but I soon became disillusioned on this score, and found that if we were to solve the enigma of the history of the gibbon and of other orthograde forms, such as the orang, chimpanzee, and gorilla, it was necessary to search for the infancy of the primate order in the geological deposits of the Eocene period, that is the oldest period of the Age of Mammals, deposits laid down two and a half million years ago, or more.

In that long-past era a most interesting evolutionary experiment was launched; the early primate world was rent in twain. In the New World, as we now name it, were isolated the early ancestors of the modern monkeys of America; the Old World retained the ancestral types which in the course of time have given us our present dog-like, or pronograde, monkeys, the small orthograde anthropoid, now represented by the gibbon, and the great orthograde anthropoids exemplified to-day by the orang, chimpanzee, and gorilla.

In the course of their evolution American apes have become adapted to various forms of progression. The spider monkey, with its long limbs and strong, flexible, prehensile tail, may be compared in point of specialisation to the gibbon, but is really a five-handed type and mainly pronograde in habit. On the other hand the little marmoset has retained, more than any other living monkey, the size and posture of body which distinguished the primates before a separation took place into New and Old World forms.

Even in the long geological period which succeeded the Eocene—the Oligocene—we find the Old World primates still small in size and retaining many marks of affinity to their separated cousins in the New World. It is at this time, too, we find early stages in the divergence of the Old World stock into orthograde and pronograde forms. Each type proceeded to diverge more and more, and to split up into a diversity of forms. In the Miocene jungles of Europe, that is those of the middle period of the Mammal Age, a phase following on the Oligocene, we find fossil remains of small orthograde anthropoids, or gibbons, and of large orthograde anthropoids—the extinct *Dryopithecques*, or tree apes, animals which varied in size but for the greater part resembled the chimpanzee.

In the Miocene and in the still later Pliocene forests of India great anthropoids, of many species, were abundant. The Miocene period has been described as the hey-day of the great anthropoids. All the facts known to us lead to the belief that the great anthropoid was evolved from the small, and that the modern gibbon represents a very ancient and persistent type which carries the imagination back to that distant and early stage in the evolution of the order of beings which in due time, in the shape of man, was to conquer the world.

I have touched on the gibbons of the distant East and have made a digression in order to explain to the reader why anatomists are so interested in this marvellous little gymnast. Every large district of the area in which the gibbon is found has its own particular species or breed, there being about ten distinguishable forms. The most distinct type of all is the Siamang, which now lives in the upland forest areas of Sumatra and in those of the southern half of the Malay peninsula. The siamang is of interest not only because of peculiarities in its structure, but because of its size of body. It may reach thirty pounds in weight, double that of an ordinary gibbon. It is the occurrence of such a type which justifies us in believing that great anthropoids may have been evolved, at a distant period, from the small.

We now turn to make a brief survey of the three great anthropoid types which have survived into

MAN AND HIS NEAREST RELATIVES

The resemblances and differences between man and his nearest relatives, the anthropoid apes, are best seen by comparing their skeletons as in this group at the Public Museum, Liverpool, which shows from left to right the gibbon, orang, chimpanzee, gorilla, and man.

our time. The continent of Africa, the home of the chimpanzee and gorilla, is being rapidly opened up. We now know that a great belt of primeval forest, the larger part of which is an almost impenetrable jungle, stretches right across equatorial Africa, beginning at Sierra Leone in the West and ending on the East at the great central chain of lakes. The total length of this forest belt is some three thousand miles; it varies in width from three hundred to eight hundred miles.

This belt is the home of the chimpanzee; but the animal occurs also just beyond the belt. The total area of its distribution is about three million square miles, an area almost as large as Europe, but there are many tracts of this vast district which have no chimpanzee population

The chimpanzee is a social animal and lives in family bands, numbering from twelve to forty individuals of all ages and both sexes. From the accounts given by travellers one infers that in the districts which are occupied they do not average more than one animal to each ten square miles. If we presume that only half of the three million square miles are actually occupied, we arrive at a crude census of the chimpanzee population, namely 150,000, an estimate which I am certain errs in exaggerating the actual number. Man encroaches upon their territory more and more every year, and when the great forest belt disappears the chimpanzee will go with it.

"Natural History" N Y

FOUR CHIMPANZEE FRIENDS READY FOR A RIDE

The anthropoids are remarkably like children in that they delight in anything on wheels, and are always ready for a ride These four chimpanzees of varied ages were closely attached to one another, and if one screamed, the big ape on the right invariably rushed to help his friend While the photograph was being taken, however, the animals remained still

Although Dr. Yerkes gives the chimpanzee first place in order of intelligence, it comes third in actual size of brain as well as in size of body. The female chimpanzee has a smaller brain than the male, but the proportional sex difference in favour of the male is rather less than holds for human races and much less than is the case in the orang and gorilla, where the male greatly overshadows the female in size and strength of body as well as in size of brain. In weight of body the chimpanzee varies from eight to twelve stones, thus resembling man, but it differs from man in having a longer trunk but much shorter lower limbs, its total height seldom exceeding four feet eight inches.

At birth the chimpanzee is only about one-third the weight of a human baby. Its mother suckles it for a year at least, until a young brother or sister comes along. The baby begins to cut its teeth at two months, whereas a human baby usually gets its first teeth at six months, and has not cut all its milk teeth until towards the end of the second year The chimpanzee arrives at the same stage of dentition when about one year old. The chimpanzee child begins to fend for itself at the age of two, and its permanent teeth begin to appear about the end of the fourth year, nearly two years earlier than in human children. All the permanent teeth, which are the same in kind and in number as in man, are cut and in use about the end of the fifteenth year four or five years sooner than in man. Chimpanzees are quite adult in their fourteenth or fifteenth year and from certain inquiries I have made I have formed the opinion that they are, in general wear of body, as old in their fortieth year as a man is in his seventieth

Chimpanzees are the most active, enterprising, and happy of all the great anthropoids. They are

playful in youth and retain through life the attributes of youth more than is the case with the orang and gorilla, but not so much as is the case with man. They interest us, too, because of certain primitive features. They are orthograde in posture, spending most of their time on the trees, using arms and legs equally. But they are also at home in the wild undergrowth which covers the floor of the jungle. Their limbs are much less specialised than those of the other great primates.

THERE is no doubt that the gorilla represents a very distinctive type of ape, and yet many find it hard to distinguish the young gorilla from the young chimpanzee. No doubt the gorilla and chimpanzee are evolutionary cousins; they have arisen at some distant period from a common ancestor. The gorilla, sooty-faced from infancy, can always be recognised by its nose. Not only is the gorilla's nose long, but its wings form rounded, fleshy folds which run down on to and merge with the upper lip. The ears of the chimpanzee are large and outstanding, while those of the gorilla are small and pressed tightly against the sides of the head. When gorillas open their mouths and show their teeth there can be no longer any doubt; the molar teeth of the gorilla are so massive and so strongly cusped. In mental nature gorillas and chimpanzees are totally different; the chimpanzee is playful and social, while the gorilla, even in childhood, is taciturn, self-contained, and irresponsive.

The gorilla also occupies the great equatorial forest belt of Africa, but its distribution is much more restricted than that of the chimpanzee. Gorillas prefer hilly country covered with jungle, and are fond of descending on disused clearings which men have made and forsaken. They also carry out marauding expeditions on native plantations, being particularly fond of shoots of the plantain and of sugar canes. They are gross feeders; bamboo shoots and succulent roots form their staple diet; quantity rather than quality is their motto. Their droppings are massive and resemble those of a horse.

On the west coast they extend northward into the Cameroons, while on the south they reach the mouth of the Congo, but never beyond it. They

H. Shepstone

F. W. Bond

HOW CHIMPANZEE AND ORANG-UTAN APPEAR IN AN ERECT POSTURE

Although it is not common or easy for any of the larger man-like apes to maintain an upright position they do stand erect when occasion demands, and these two photographs show how very upright their attitude can be. The chimpanzee (left) seems perfectly comfortable as he stands with folded arms; but the orang (right), though quite as straight, seems less at ease. Note that while the chimpanzee supports himself on the soles of his feet, with his toes tucked underneath, the orang stands on the sides of his feet, a most uncomfortable position.

F. W. Bond

AGED MALE ORANG WITH CHEEK POUCHES

The male orang utan in his later adult years develops cushions or pouches on the sides of the face. The female never possesses such facial ornaments and therefore remains more human in appearance. The white marks are wisps of straw from the ape's bed

stretch to the east as far as the great lakes. It was only at the beginning of the present century that they were discovered in the volcanic mountains to the west of Lake Kivu, and they even reach the neighbouring frontier of Uganda. In Eastern Central Africa gorillas live in the damp, cold, bleak bamboo jungle which clothes the ravines and sides of these high mountains. They are found living at a height of eight or even ten thousand feet. Although we have many records of the occurrence of gorillas in the western and eastern extremities of the forest belt, they have been seen only very rarely in the intermediate areas.

GORILLAS live in small bands, which seldom contain more than ten individuals, each band being led by a massive old male with usually a young male or two to serve as understudies. Each band apparently represents a family, and includes two or three adult females with young at various stages of growth. How sparse the gorilla population is, even where the animals abound most, may be seen from the records of Du Chaillu. That traveller, in the course of four years, covered eight thousand miles on foot, and yet succeeded in shooting or capturing only seventeen individuals. If we estimate the total gorilla population at fifty thousand, I feel certain that we have exaggerated the numbers. If all were gathered together they could be accommodated in one of our smaller county towns. Nor are their numbers increasing; the opposite is the case. The gorilla is a dying race.

The gorilla changes exceedingly as he grows up—far more than the chimpanzee and man do. He is born small, being less than half the weight of a new-born human infant, but the adult male usually weighs as much as two ordinary men. An old male gorilla which Mr. T. A. Barns shot on the volcanic highlands of the Eastern Congo near Lake Kivu, weighed 450 pounds, over 32 stones. It took ten natives to lift and carry his carcase, and they staggered under their burden. The gorilla child cuts its teeth and becomes mature at very much the same time-periods as the chimpanzee, but growth, especially of the male, is much more rapid. Although the prevailing colour of hair is some shade of dark-brown or even black, a touch of red is common, especially in the hair of the scalp. In old age the hair turns grey.

The gorilla is the Hercules of primates. His strength of jaw and limb is enormous; in muscular development the adult male surpasses the strongest of our Jack Johnsons; an ordinary average specimen has the strength of five men. The evolutionary trend of the gorilla has been toward the acquisition of sheer brute strength and mass of body. The male animal has become a veritable giant—not in height, for its total stature reaches only about six feet, but in bulk of body and power of limb.

F. W. Bond

"APING" THE MAN

There are few human actions that a chimpanzee cannot be taught to imitate but in the use of a hair-brush he needs no teaching at all. He has only to see a man brush his hair and if the brush is passed to him he will quickly reproduce the action on himself.

In the chimpanzee the evolutionary trend has been in the opposite direction; the chimpanzee represents the light cruiser, whereas the gorilla is modelled on heavy battleship lines. The trend towards sheer strength has brought about a change in the habits of the gorilla of a very interesting kind. Every structure of the gorilla's body proclaims that it was originally designed for life in the trees, but with the evolution of bulk the old male has become too heavy for climbing, and has been forced to spend his adult life on the ground among the undergrowth of the jungle, supported on his bowed legs and using his long, stout arms as crutches. The females and the young still retain their arboreal habits. Most of their time, however, is passed on the jungle floor.

Of the great anthropoids, gorillas have the lower limbs best developed; it is remarkable that in their legs a certain special muscle is occasionally developed, a muscle which otherwise is found only in the leg of man. It is also remarkable that many gorillas also possess a special muscle for the thumb, one which is constantly found in man, but in no other animal. The hand of the gorilla is massive and extremely clumsy, while the sole of his foot makes an imprint which covers three times the area of that made by the foot of adult man.

I have made no mention of the nest-building habits of the chimpanzee; such nests are rough, temporary platforms fashioned out of bent and broken branches—not unlike nests made by our wood-pigeons, but of even cruder workmanship and measuring three or four feet in diameter. The great anthropoids share man's habit of sleeping in a reclining position; hence every night they have to provide themselves with sleeping platforms or beds.

At night the old male gorilla makes a shake-down of branches at the foot of a tree, while the young animals and females of his band spend the night on platforms roughly fashioned on neighbouring trees. Dr. Dyce Sharp informed the writer that all members of a family post themselves at night within sight of the old gentleman's bed. Orangs also build similar platforms or beds.

The orang builds very rapidly. Some years ago an adult orang escaped from his cage in the Zoological Gardens, London, and in less than half an hour constructed a platform on a tree adjoining the anthropoid house.

We must not suppose we have discovered all the secrets of the gorilla world. It was only at the beginning of the present century that Captain von

F. W. Bond

BOSOM FRIENDS IN CAPTIVITY: TWO YOUNG ORANGS AT LONDON'S ZOO

Orang-utans are easily tamed and trained, and owing to their very human appearance they are great favourites in all zoos, where children and grown-ups alike love to watch their quaint antics. They are fond of companionship, and two young orangs like these will form as close a friendship as any human beings could do. The one on the right is showing marks of real affection as he embraces his companion, while the other solemnly waves his arm as though he is wishful of attracting the attention of the photographer or of some other visitor.

THE ORANG'S BED IN THE TREE-TOPS
The orang-utan builds a platform of branches in the tree-tops and uses it as a bed, where it can sleep in peace, safe from enemies that might attack it if it were caught on the ground. This platform is well constructed, and is put together with amazing rapidity.

Beringe discovered the Highland or Kivu gorilla in the volcanic mountainous ranges near Lake Kivu. The Kivu gorilla can be distinguished at a glance from the gorilla of the West by his hairiness, his occipital crest, and his stocky build of body. But in muscle and bone and brain the eastern gorilla differs in no distinctive way from the gorilla of West Africa. There are thus at least two distinct races of gorillas—the lowland, or western, gorilla and the highland, or eastern, gorilla.

In spite of his great strength, his powerful jaws, and dagger-like canine teeth the male gorilla is not an offensive animal, but can be terrible in defence. He will fight ferociously, but only when attacked or when his home is invaded and his followers threatened. He never runs away when the safety of his band is endangered, but courageously faces his foe.

We must, in concluding, touch upon the great anthropoid of the East, the orang-utan. In recent years whole families have been captured in Sumatra and brought to Europe for a medical purpose of most doubtful utility. No one who has viewed a family of father, mother, and baby orangs in captivity behind the iron bars of a cage will ever forget the sight, so pathetic is it. Such a scene cannot fail to move the most thoughtless. It is much to be desired that such a nefarious trade and practice should be made impossible. For by nature the orang is the most timid and inoffensive of animals. The male orang is a massive anthropoid weighing 170 to 200 pounds, covered with long red hair, and in late adult years developing curious cushions on the sides of the face, in front of the ears. The female orang never possesses these facial ornaments and is a much smaller animal than the male, weighing twenty to thirty pounds less. The newly born baby is only about one-third the weight of a human baby; it reaches maturity about the fourteenth year and is old at forty.

The orang is purely arboreal, descending to the ground only under compulsion. He is a slow climber, lethargic in his movements, using his long arms and hook-like hands as the main means of progression from branch to branch and from tree to tree.

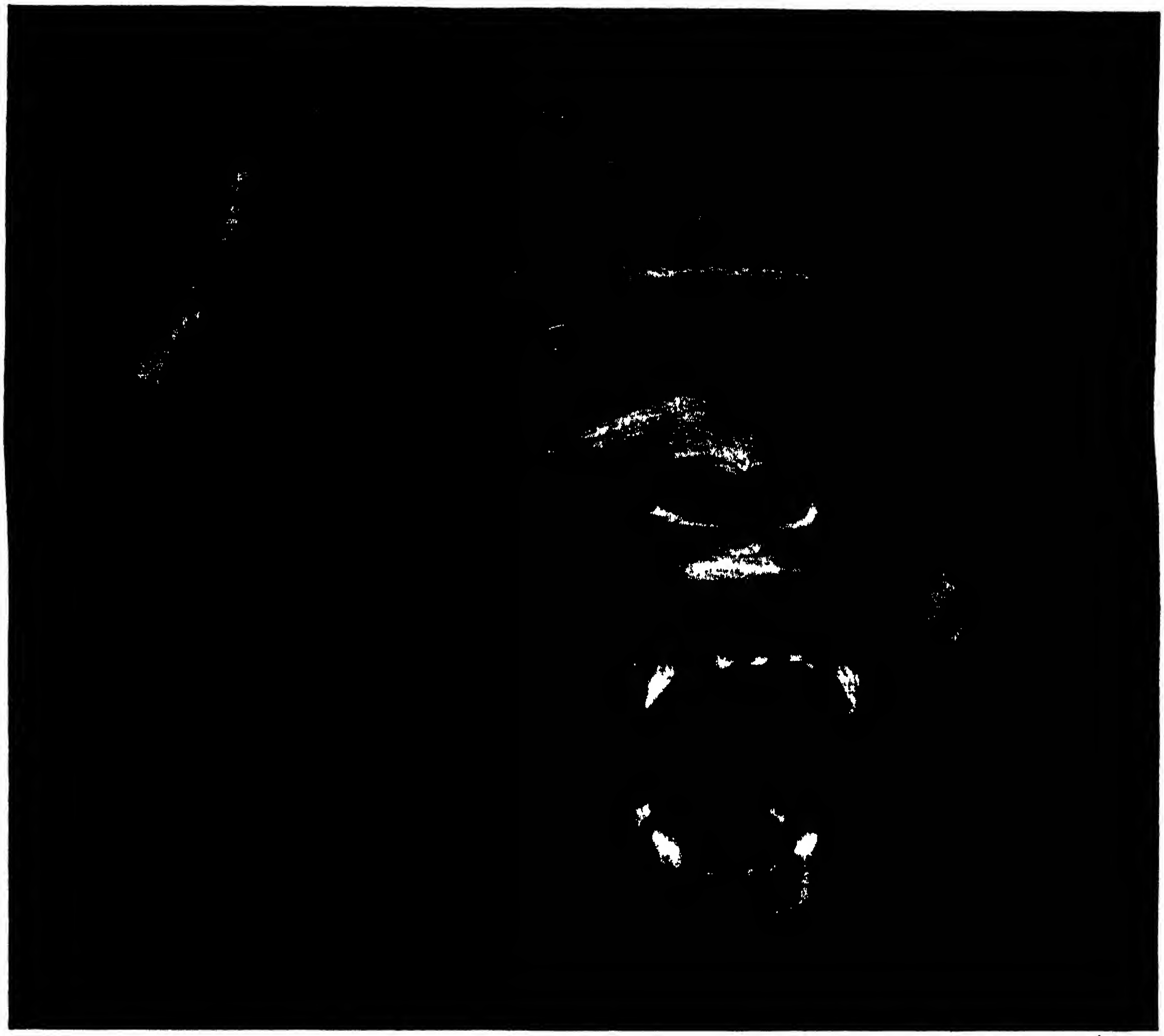
This predominant use of the arms has led to a remarkable atrophy of the lower extremities, which serve purely as grasping organs. It is also noteworthy that the thumb and great toe are much reduced in size and are apparently on the way to become mere vestiges—if the orang race survives long enough for such a process to be completed.

The area occupied by the orang is much less than that held by chimpanzees in Africa. Orangs are found within a wide tropical belt which covers the western parts of Borneo and in the north-western half of Sumatra. The total area inhabited by them cannot exceed 200,000 square miles; even if we allow one animal to every five square miles—a too liberal allowance—the total orang population would amount to only forty thousand. It is very possibly little more than half this number.

The anthropoid world, which I have hurriedly surveyed with the eyes of a registrar-general rather than of a naturalist, differs altogether from that of man. Anthropoids are the slaves of circumstances, being dependent, from day to day, upon what they

C. E. Akeley

HOW THE GORILLA MOVES ABOUT
Habitually the gorilla does not adopt an upright attitude, but moves about on all fours with a curious swinging motion, using its arms as crutches and bringing its huge body forward with a kind of jump. When facing an enemy, however, it will rise as shown in page 5



Autotype

THE FIERCE MIEN OF THE MALE GORILLA WHEN DEFENDING HIS FAMILY FROM ATTACK

Though ordinarily the gorilla is not aggressive, he can become terribly ferocious in defence of his females and their young, and when he opens his mouth he displays huge, dagger-like canine teeth that are truly formidable. The evolutionary trend of the gorilla has been toward the acquisition of brute strength and he could easily master five men. The museum specimen from which this head was photographed was one of the finest ever shot, and the picture gives a good idea of the animal when roused to wrath.

can gather from Nature's table—and a jungle table is a precarious one. All of them remain far below the level of organization at which the brain becomes capable of conscious effort; they are untutored children of Nature, ignorant of tools, and incapable of the simplest mechanical invention.

Man, even the lowest we know of, has risen far above the anthropoid level and become a conscious inventor. Man has succeeded in making ten square miles of land support a population of five thousand individuals—an area which, in its virgin condition, would provide sustenance for only one ape. The result has been that humanity now numbers about 1,800 million souls, all being varieties of one species; whereas the great anthropoids, which represent three different genera, cannot muster a total of 300,000 amongst them, a number equal only to the population of a single modern city.

We see, too, how precarious is their hold on life in our world. The primitive tropical forests are disappearing before the growing needs of civilized man, and when these tropic jungle belts have gone no home will be left any longer for animals which have, or should have, man's most sympathetic consideration. For there was a time when mankind was just as sparsely represented as these animals now are and was just as dependent on what fell from Nature's table. From the anthropoid world of to-day man can obtain a glimpse of his own remote past. For there was a time when mankind was also divided into very diverse forms, each native to a confined area of the earth's surface.

Chapter II

The Wonder of the White Ant

By Hamilton Fyfe

If an explorer were to tell us he had found a race of men who could control, not merely the sex but the character and the bodily structure of their children; if he were to relate how they produced, according to the needs of the community, labourers or soldiers, parents or nurses, we should at first almost certainly disbelieve him.

Were he to convince us of the truth of his story, we should call this one of the marvels of the universe. We should want to learn as much as we could about it. The methods employed would be of enormous interest to us. We should feel that the scope of Will and Intellect had been vastly enlarged, that one of Nature's most jealously guarded secrets now lay open before us.

That is the feeling created in every mind capable of reflection and imagination by a study of the Termites. They are not indeed human beings, but does that make them any less wonderful? Surely it is more wonderful that tiny, weak creatures, the easy prey of countless enemies, without any of the advantages which man prides himself on possessing, should know so much that is hidden from us; that they should have been able for unnumbered ages to do as a matter of course and daily habit what we with all our skill and ingenuity cannot either accomplish or understand.

That ants and bees are in their way as astonishing as man is known to all who have read even simple accounts of their activities. The hive is a model state which in its working and results surpasses any system of civil government elaborated by human beings. It is not fantastic to say that bees and ants have civilizations of their own, for a civilization implies a discipline which allots to every citizen his or her duty and keeps always the general good in view. Such discipline is far stronger in the hive and possibly in the ant-heap than it has ever in any age been among men. Among the termites we see it even more efficient.

Prof. R. W. Doane

TURRETS BUILT BY AMERICAN TERMITES

Some white ants instead of building towering structures of Gothic appearance erect slender turrets like these. The one on the left was built near a house in California, and that on the right is interesting as standing quite out of its centre of gravity.

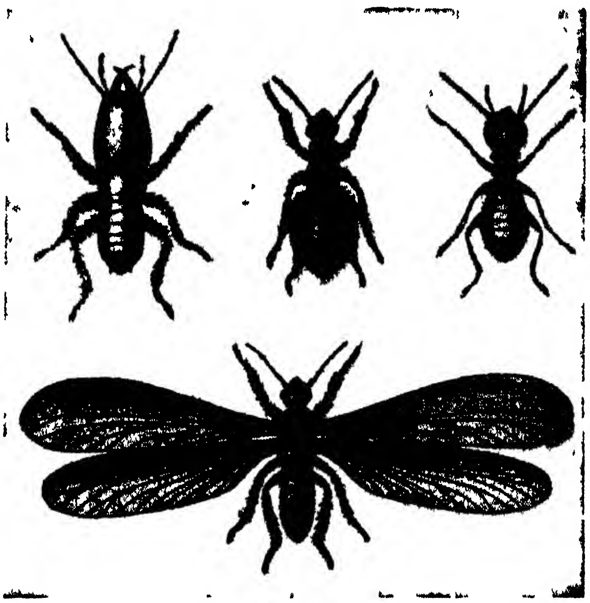
These insects are commonly known as white ants—commonly, but erroneously, for they are neither ants nor white. Their colour is as a rule more or less that of the earth in which they live. They are a distinct genus, unlike ants in most important particulars and carrying on perpetual war with them. There is a wide range of variation among termites; nearly fifteen hundred different kinds are known. They are found only in hot climates, which has saved the north of Europe from them. They are reckoned to have been in existence on the earth for between two and three million years—yet it was only a century and a half ago that they began to be studied seriously.

This was all the more curious seeing that their homes and their habits are so much in evidence in the countries where they live. In Africa one sees often tall columns which appear to be of earth. For the most part these are from six to ten feet high; they may run up to twenty. In Australia the termitaries reach a height greater than that. Sometimes the mounds and columns have a large circumference. They are always plainly visible; indeed they are often the most prominent objects in the landscape. The termite is very seldom seen himself, but he makes no attempt to conceal his buildings. These are unnecessarily, even dangerously, conspicuous.

Nor is it possible in a tropical country to remain unacquainted with the destructive habits of the termites. Everything that is not of metal they can eat, and do eat if they take a fancy to it. Nor do they eat in an open, straightforward, *honest* way. They never start on the outside of anything. They gnaw their way in somehow, and continue gnawing until nothing but the outside is left. Thus, you may see what looks like a perfectly good tree, but at a touch it crumbles. You may sit on what appears to be a sound chair and have it collapse under you. You may push

open a door and see it fall off its hinges because the termites have hollowed out the door-posts, which dissolve into dust.

"In the hot and tropical parts of the surface of the earth," testifies W. W. Froggatt, the Australian naturalist, "there is no family of insects whose members wage such an unceasing war against the work of man." Jamestown in St. Helena was once attacked by them; a large part of it had to be rebuilt. The most surprising stories are told about their ingenuity and cunning. They can even bite through metal if they have time to rust it with a juice which they exude. In an account of Oriental travel an author named Forbes told of all his pictures and picture frames being eaten away as they hung on his walls. Only the glass was left, and that had been cemented to the walls!



H. Bastin

MEMBERS OF THE TERMITE FAMILY

The various castes in a white ant family vary greatly in appearance as can be seen here. At the top reading from the left are a worker, a reserve female not yet distended with eggs, and a soldier, while below is a typical winged male.

There is so much that seems incredible in the lives of termites that it would be rash to exclude any possibility. M. Maeterlinck is indeed inclined to credit them with an intelligence superhuman in some directions. In his book "The Life of the White Ant" there is much poetry and not a little philosophy added to a passionate interest in his subject and a comprehensive acquaintance with it. Some think that he falls into the error which poets are prone to make of speaking about creatures without self-consciousness as if they could experience "misery," "joy" or "resignation," in the same degree as we do. Yet M. Maeterlinck throughout most of his book keeps close to facts, drawing them from naturalists of authority; and the story he tells is one that leaves the mind of the reader, as it left his mind, groping eagerly for answers to the many questions it suggests.

In size the termite is not much larger than a wasp or small beetle; in shape it is like an ungainly ant. Once all termites must have had wings. Now it is only what we may call (for convenience rather than with any approach to exactitude) the royal line that emerges into the world able to fly, and for all but a very few of the "princes and princesses" this means immediate destruction.

This royal line is kept up for the purpose of insuring that the termite race shall not die out. Its members are the only residents in the termitary capable of reproduction. In each termitary there is a queen's cell. There lies the mother of the community, engaged in her business of laying eggs. That is her sole function, her sole occupation. She is enormously larger than any of her "subjects." She is hideously bloated and swollen. Her consort, small and timid, remains near to his immense spouse, but keeps as much as possible out of sight.

The domed cell, which we might almost call a sanctuary, is filled with worshippers who show their devotion by caressing, licking, even biting their huge, sausage-like divinity. There are guards who do their best to prevent her from being bitten, and who "move on" throngs which gather in too large numbers at any particular point. There are also soldiers of more formidable aspect who stand sentinel all round the cell.

The queen is fed by her attendants; she cannot feed herself. As the eggs drop, they are received by other servitors, washed and carried away to be stored in heaps in chambers above. Should the queen cease for any reason to lay eggs, which she does at the rate of sixty a minute, 86,000 a day, thirty millions a year, she is doomed. Her normal term of existence is from four to five years. During that period, if she remains healthy, she continues to produce eggs at the same rate without ceasing, day or night. If the flow is interrupted, the community recognizes that her value to it has gone. Her attendants stop feeding her. She perishes of starvation. Then her corpse is devoured and a fresh egg-producing machine is installed in her place.

Here we come to the marvel of the termitary which has probably the most vivid interest for most human beings. It is not necessary to keep a stock of reserve royal mothers, though sometimes this is done, and sometimes a queen whose fertility diminishes is allowed to live and to share her position and duty with associate egg-layers. If there is no individual of the royal line to take the place of a queen who has lost her powers, the termites can turn into a queen any of the millions of larvae which are stored in their "nursery," or can force any egg to yield the sort of creature they require.

Exactly how this miracle is accomplished is not yet known. Diet, massage, surgery, regulation of air and temperature, may all be employed. How the eggs are treated is a mystery even more profound.

ONE OF THE BAFFLING MYSTERIES OF THE WHITE ANT SOLVED

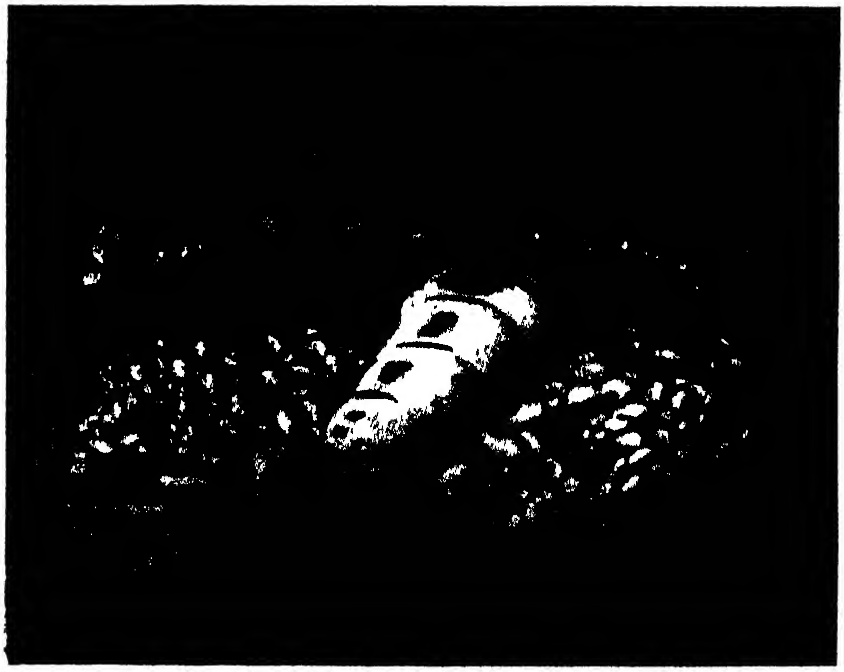
Existing in countries subject to droughts, it has long been a mystery how the termites obtain the moisture they need This was solved by accident At a place where a 65 ft shaft had been sunk in vain to obtain water it was found by Mr Eugene N Marais that the termites succeeded where man had failed they went deeper down. Our diagram shows on the left a section of the well-shaft and zig zagging down the same earth is the termites' tunnel with fungus seed beds 'y' planted at effective positions. In the lower centre the explorer is examining a portion of the termites' tunnel and seed beds, the latter on an enlarged scale. Above is a sectional view of the termitary

One further point to notice. Since the associate-queen produced in this way has no need to fly or to see, as have the princes and princesses who take part in the annual flight, she is provided neither with wings nor with eyes. If that be not accepted as proof of an intellectual process, maybe far in the past, it is very hard to know how to account for it.

THIS annual flight, or swarming, suggests, on the other hand, the maintenance of a tradition which might long ago have beneficially been discarded if intelligence were supreme in the termitary. What happens is this. As the summer draws to its end, the walls, which at all other times are so carefully kept solid in order to exclude both light and other enemies, are pierced by a number of openings. From these fly out masses of perfectly formed termites, with eyes and wings and reproductive organs. They have been nourished at the expense of the community. They are unable to feed themselves. When they are hungry, they tap a nurse or a worker with their antennae and receive a morsel of food already digested which the others exude from their stomachs if it is for the young; from their intestines for the fully-grown.

Why does the community allow so vast a proportion of its members to live without working? Why does it persist in producing so vast a quantity of consumers who contribute nothing to the common stock? Certainly the termites must secure the continuance of their race. They need a certain number of mothers and fathers. But nothing, it seems, can explain the immense cloud of possible parents which issues from the termitary once a year save mechanical adherence to an ancient habit for which the reason has long passed away.

For as soon as they have issued, almost all these possible parents are destroyed. An array of enemies, warned in some way of the feast that will be spread before them, awaits the unsuspecting swarmers as they come forth in a dense cloud and attempt to fly towards the upper air. The effort is quickly over. Their wings fail them, they fall to the ground, they become the helpless prey of the ants and other insects, the birds, the snakes and toads, the cats and dogs, the men even (baked or toasted, royal termites are eaten by the natives of several countries), who have been on the look-out for them. In a short time none are left on the ground. Only a small number have managed to escape; by them new colonies will be formed. They will be the kings and queens of new termitaries. Wasteful Nature thus appears to us to sacrifice countless lives in order



A. Montgomery

F. Martin Duncan

THE PRISONER QUEEN AND HER ARMY OF ATTENDANTS

The sole function of the white ant queen is to carry on her race. She lays eggs at the rate of 86,000 every 24 hours. The average life of this astounding egg-producer is five years, during which time she lays about 150 million eggs. The lower photograph (approximately life-size) shows a queen with a soldier termite for comparison, and above she is seen surrounded by her attendants, who feed her and carry away the eggs.

that a few pairs may be able to come together and carry on the reproduction of the species.

The moment the flight has taken place and all the winged termites have quitted their home, the openings in the walls are closed up again. This is done with astonishing speed; the method of it is not less strange. Much of the building material of the termites is, to begin with, swallowed by them. They extract what nourishment is in soil or wood or grass; the waste matter they discharge. Sometimes this is eaten again and again

W. Saville Kent

CATHEDRAL-LIKE EDIFICES OF THE WHITE ANTS IN AUSTRALIA

The industry of the white ant, or termite, is indeed amazing. In a short time it throws up a building with spire rising on spire, like some Gothic cathedral. In the upper picture is a landscape in North Queensland dotted all over with termite hills 13 or 14 feet high, made by a species that always builds with the long axis in an exact line with the North and South poles of the Magnetic meridian. The bottom left picture shows an end-on view of one of these buildings of the Meridian termite and on the right is the hill of another species found in West Australia.

until all the food value has departed from it. Sometimes it is used as building material along with sand and wood.

A French naturalist, M. Bugnion, has described vividly how they use it. He cut into a termitary in Ceylon nineteen years ago. He made a hole in the wall nearly an inch long.

> Immediately ten or a dozen soldiers appeared at the hole, then advanced a little and formed a circle with the horns on the front of their heads pointed outwards as though they were prepared to meet the invader. A quarter of an hour later the work of repairing the damage that had been done was busily in progress. A file of soldiers lined the gap, their heads outside, their bodies within. Waving their antennae, they were biting the edges of the opening and making it wet with their saliva. Already I could see all round it a trace of moisture which made it deeper in colour than the rest of the wall.
>
> Soon a worker termite appeared. It examined the gap with its antennae, then it turned round and from its rectum expelled a tiny drop of thick brownish fluid. Another worker then brought a grain of sand, which was placed upon the drop.
>
> This went on over and over again in the most methodical fashion. For half an hour I watched workers come up one by one, inspect the gap, turn round and deposit their tiny drops, and other workers bearing grains of sand or little scraps of wood place them in position. All the time the soldiers, moving their antennae briskly, seemed to be there for the purpose of guarding the workers and directing their labours.
>
> The repairing of the inch-wide breach, done entirely from inside, took an hour and a half.

This same M. Bugnion saw and photographed a host of 300,000 termites marching to and from a tree that happened to have on its bark a lichen of which they are very fond. They went at the rate of three feet a minute and marched between two rows of soldiers who protected them from hostile and marauding ant skirmishers and occasionally fought rearguard actions to cover the retreat of their comrades loaded with lichen.

These soldiers were armed, not with the powerful curved scissor-blade mandibles which distinguish most of the termites, but with syringes, from which they discharge a sticky fluid. The syringes are part of their anatomy, growing in place of a head. As they are without heads, they are without eyes, but they seem to have some sense which tells them where enemies are, for they manage to direct their squirting quite accurately.

Another French naturalist, M. Bathelier, of Saigon in Indo-China, put some of these squirt-carriers into a basin with some large red ants. The ants were soon put out of action. The fluid made their legs and wings stick to their bodies.

M. Bugnion, too, had a good opportunity to observe the syringes in use. He had put a number of the termites who have these soldiers into a box with a glass top to it. The top did not fit well, and when he came in one morning and saw the table on which the box stood covered with ants of a very fierce kind, he feared his termites must have been annihilated. But he then saw the syringe soldiers standing on the table round the box, and also by the groove into which the glass top did not fit. They had been on guard all night. Not a single ant had got past them.

The more usual kind of soldier-termite fights with its scissor-mandibles and is protected by a covering of horn. If ants or other foes succeed in piercing a termitary wall, they rush to the spot as soon as the alarm has been given and thrust their weapons outwards, thus stopping up the breach with their heads. While the battle goes on they make rhythmic noises which can be heard from a distance of several feet. If ants fight their way into the termitary, the soldiers engage them while the workers close up all the passages. Thus the home is saved, but its defenders are sacrificed, for they are left outside.

The workers, like the soldiers, are sexless and blind. Unlike the soldiers, they have no defensive apparatus. Another point of difference is that the workers can feed themselves, since they are provided with digestive organs. With these they do the digesting for the whole community. It is no easy task, for termites live on cellulose, and cellulose is very hard to assimilate. The workers are able to assimilate it by reason of the organisms known as protozoa, which swarm in their intestines. The protozoa are able to digest cellulose (which is the substance of trees, plants, grasses, roots) ; the termites are able to digest them.

Some sorts of termites go to work another way to overcome the difficulty of assimilating cellulose. They cultivate large quantities of an infinitesmal mushroom which feeds on cellulose, and they live on these mushrooms, which give them their nutriment in a pre-digested form. Only in termitaries will the mushrooms grow. Efforts made by men to produce them have failed. The termites collect the spores, sow them on prepared beds, and keep them weeded and watered. When a move is made, the founders of a new colony always carry with them mushroom spores so that they may supply themselves with food.

The workers are, as we have seen already, divided into two categories. Some are large and have sharp, strong mandibles, something like those of the soldiers, but not so powerful. These do all the hard work. They build and repair ; they go forth on foraging expeditions ; they cut up wood and other substances which are needed for food. The smaller kind of workers remain in the home. They are the housekeepers, the nurses. They feed all those who cannot feed themselves. They look after the eggs and the larvae. They store up the food which the foragers bring in to the termitary.

Here we come to another of the specially wonderful sides of the termites' activity. Not only is it necessary to keep the whole place pretty warm. It is essential that the temperature of the "nursery," where the larvae remain until they hatch out completely, should be higher than that of the rest of the termitary. This is managed by regulation of the heat generated from the fermenting of vegetable matter stacked at various points. The termites, in fact, invented central heating a million years or so before even the Romans thought of it. They make the warm air circulate in little corridors running through the termitary in every direction. As for ventilation,

Leon Bayer, M.D.

A SKYSCRAPER BUILT BY THE LITTLE WHITE ANTS OF AFRICA

The tallest skyscrapers built by man are like bungalows compared with the homes erected by the white ants, if we take into consideration the relative sizes of the two builders. Here is a great column nearly twenty feet high, built of the hardest material—man can produce nothing to equal it—by the termites of East Africa. It was photographed by Dr. Leon Bayer, who says it is hollow and probably helps to regulate the moisture in the termite galleries that lead many feet below the surface. Openings at the base often shelter small mammals

Chapter III

The Marvel of Animal Coloration

By W. P. Pycraft

Author of "Camouflage in Nature"

Whether we consider the beasts of the field or the fowls of the air in regard to their coloration we are soon faced with strange contrasts. It is as though we were looking at some old illuminated manuscript enriched with scrolls and arabesques and gorgeous blendings of gold, lapis-lazuli, and vermilion set on the fringe of a crowded text formed of letters presenting a dreary uniformity: which may, or may not, after due study, prove edifying.

Why are the peacock and the bird of paradise so gaily apparelled while the sparrow and the wren wear plain russet the year round? We may go farther and ask, Why are they coloured at all, and whence come their hues?

Our search for an interpretation soon brings out the fact that coloration, in itself, is not an essential; since myriads of animals have translucent bodies, to wit, myriads of the microscopic protozoa, jelly-fish, and those strange, incipient vertebrates the salpae, as well as larval fishes, and newts. These living ghosts, however, it will be noted are all aquatic.

When we come to survey that larger assemblage of animals whose bodies are more or less conspicuously coloured we are tempted to conclude that somehow this coloration, from its very universality, must have some deep meaning: that it must, in short, be essential to their well-being.

But such a conclusion would be only partly justified. For it becomes apparent, after a little search, that coloration is an inherent quality wherever it is met with, quite apart from any relation it may have acquired with the outer world.

This much is forcibly demonstrated in the case of the cone-shell. As will be seen in the photograph on page 29, showing two such shells, the surfaces are marked by a very definite pattern. Yet, so long as the creature lives that pattern remains invisible; for it is hidden under a thick layer of epidermis. Only after death, when all the perishable tissues have vanished, is that pattern revealed.

The living conus has a coloration absolutely different from that which covers the concealed shell. Has this also no meaning?

Enough has now been said to show that we may not formulate theories without carefully weighing the facts on which such theories are based. We have to suspend judgment till we have studied the coloration in relation to its environment, in relation to its character, and in relation to the habits and sex of the individual presenting this or that combination of colours which we call the "coloration." But of this more presently.

What follows will be the more easily grasped if something is said now as to the source of this coloration. Briefly, then, it is due in all cases, directly, or indirectly, to pigments which are of two main types—melanin pigments and lipochrome pigments. The melanin pigments are derived from the blood. They are waste-products, deposited in the skin, hair, feathers, or scales, as the case may be, instead of being carried out of the system altogether with other waste products. Dark brown and black are among the most conspicuous of the various melanin pigments.

Yellow and red are lipochrome, or fat, pigments, and hence are derived from the reserves of the body. Other pigments known as derived pigments, because they are drawn directly from the corresponding constituents of the food, as in the case of the green colours of caterpillars, are found only in a few cases.

But however derived, it does not always follow that these pigments serve any useful purpose. They may, indeed, be accidental properties of the substance they pervade. The red colour of blood, for example, or the green colour of the bones of some fish, like the gar-pike or the American amia, cannot be regarded as purposeful colours.

But be this as it may, one may safely say that the coloration of most creatures is purposeful. Any animal which tended to develop a coloration rendering the body conspicuous would expose itself thus marked to its enemies, while those of duller hues would escape. The recognition of this fact was first made by Darwin. It was left to Professor Poulton to work out its full significance.

To-day we recognize several distinct types of coloration. Of these the most important are protective and warning coloration, mimicry, and the coloration associated with what are known as the secondary sexual characters.

Examples of protective coloration might be cited by the hundred. But none more convincing can be found than are furnished by the sitting pheasant, or partridge, or wild duck. So long as they remain perfectly motionless they are invisible.

We see here that the precise pattern of the individual feathers is of no consequence; for each of these species has its own peculiar patterning, but the general effect in all cases is the same—a mantle of invisibility.

In some birds the coloration is associated with a special posture of the body when fear induces a desire to escape detection. In the bittern the whole body is held vertically, the beak pointing skywards. At the same time, care is taken always to present the under surface to the source of danger, as if conscious of the qualities of its coloration. For the front of the neck and breast now present a series of dark vertical lines on a paler background, harmonising perfectly with the shafts of light seen between the

W. S. Berridge

MOST BRILLIANTLY COLOURED OF ALL THE MAMMALS

The mandrill offers an unsolved problem in animal coloration. Its amazing colour scheme, scarlet nose and cobalt blue cheeks, which are furrowed as though a miniature plough had been over them, puzzles the scientists, who cannot say how such brilliant hues were first developed or of what use they are to the male who alone wears them. No other mammal is so brightly coloured.

To face page [illegible]4

tall reed-stems. The Norfolk plover (*Oedicnemus*), again, matches the sandy wastes on which it lives. When alarmed the bird throws itself flat upon the ground, with the neck stretched straight out and pressed as close to the earth as possible. So long as it remains perfectly still only by the merest accident will it be discovered. The night-jar, similarly, lies along, instead of across, the bough of the tree wherein the hours of daylight are spent. And in this position it so closely resembles the bark that detection is well-nigh impossible.

But it is not only the creatures which desire to escape being eaten that wear a mantle of invisibility. The wolf must wear sheep's clothing if his fashion is to steal upon his prey unawares. And so the tiger haunting grass jungles wears a hide which is vertically striped; the leopard, lying up in a tree, is spotted; the spots harmonising with the play of light through the leaves, and breaking up the solid appearance of the body, thus causing it to blend with its surroundings.

THAT these harmonies between coloration and environment are no mere coincidences is further emphasised by the fact that deer which live in tropical forests, like the axis deer, have a spotted hide the year round; while such as live in woodland glades, leafless for half the year, have a spotted hide only in summer, the winter covering being unicoloured.

F. Martin Duncan

BUTTERFLY THAT PRETENDS TO BE A LEAF

This butterfly, the Kallima, is of purplish blue and yellow and in flight is very conspicuous. If pursued by a bird it disappears, the explanation being that it has alighted and closed its wings which, on the underside, resemble a dead leaf.

Sometimes, as in the case of butterflies and moths, two quite different liveries are worn at one and the same time; one being exposed during flight, the other when at rest. In other words, the upper and under sides of the wings are differently coloured. The butterflies, when at rest, keep the upper surface of the wings closely pressed together above the back, and this surface is generally much more conspicuously coloured than the under, though the swallow-tail and some others are exceptions to this rule.

The famous kallima butterfly of India, the Malay Archipelago, and Africa affords a peculiarly striking example of an insect which is able to change his coat, so to speak, in the twinkling of an eye; how the racecourse welsher must envy him! During flight the wings present a broad expanse of dark blue, relieved by a wide band of golden yellow. But the flight is erratic, and if pursuit becomes at all pressing it will cease instantly, the gaudy body vanishing as it were into thin air. What has happened? Keep a watchful eye on the leaves of the bush over which the flight ceased. Sooner or later one of the leaves will show the faintest suspicion of a double edge, and the next moment the gap may widen, revealing the blue and gold of the lost fugitive. If the under side of the wings of a captive specimen be examined the mystery will be explained. For the coloration reproduces that of a dead leaf with the most astounding fidelity. There is the mid-rib, the venation, and even spots and clear spaces as though due to the attacks of fungus. The mid-rib runs down into a short stalk, formed by projecting spurs from the hind wings; these, when brought close together, form the stalk, and apparently spring from the stem like a leaf.

WITH the moths the wings, when closed, are held horizontally over the back, the fore-wings completely concealing the hind-wings. When the wings are expanded it is found that it is the upper, and not the under, surfaces which have to be considered in regard to their coloration. Where this is of a protective character the necessary camouflage is borne by the front-wings, and when these are expanded they disclose a blaze of colour, as, for example, in the red and yellow underwing moths. The poplar hawk-moth, and some others, when at rest, thrust the hind-wings slightly forward, so that they stand out a little beyond the outer edge of the fore-wing, thus giving a leaf-like appearance to the body; the coloration, of course, adding the finishing touch to the deception.

Occasionally not merely the coloration but the whole body is shaped to perfect this likeness to the external surroundings. Many of the looper caterpillars, for example, as of our swallow-tailed moth, peppered moth, and brindled beauty, take on so close a likeness to the bare twigs among which they hide as to make detection extremely difficult. These have long, cylindrical bodies, and have reduced the number of their legs to help the deception. Grasping the twig on which it is resting by a pair of clasping-legs at the extreme end of the body, the creature

TWO REMARKABLE EXAMPLES OF PROTECTIVE COLOURING IN ANIMALS

The colouring of defenceless animals is often of such a nature as effectively to conceal them from their enemies and the giraffe (below) and zebra (above) are two notable examples. The vertical stripes of the zebra, which make it so conspicuous in a zoo, harmonise with the long grass of the haunts in which it is found. Similarly the tall motionless figure of the giraffe, with its body colour broken up into blotches, blends so completely with the trees and shrubs amid which it rests that it is lost sight of, even though it may have been located while moving.

The photographs are from Mr and Mrs Martin Johnson's famous film "Simba"

contrives to stand out stiffly at a wide angle from the supporting twig, as if it were a part of the plant. And it will maintain this position without the slightest suspicion of a tremor throughout the long hours of daylight, unseen and unsuspected. Some of these caterpillars, like those of the purple-thorn, develop excrescences on the body simulating the leaf-scars on the surrounding twigs.

A SPIDER found in Java, and another nearly-related species found in Ceylon, spin silken webs on a leaf to simulate the liquid part of a bird's excrement. Taking its place in the centre of this the spider forms the darker area of the patch, and here it awaits butterflies and other insects coming to sip at the welcome moisture. As soon as they alight they are seized!

A few of the mantises have, by a seemingly diabolical cunning, so changed their bodily shape and coloration as to cause them to be mistaken for gaily-hued flowers. We say seemingly advisedly, for it is not to be supposed that this is a conscious likeness, or has been assumed by taking thought. A striking instance of this disguise is furnished by the Indian mantis (*Hymenopus bicornis*). The general coloration of the body is pink, and the petals of the flower are simulated by the flattening out of the legs. Hanging head downwards it awaits its unsuspecting victim, which presently comes near enough to be seized by the long fore-legs, fashioned to form deadly traps by reason of the fact that they are enabled to fold back the terminal segment of the leg upon the segment next above it, like the blade of a clasp-knife; the edge of the blade being armed with formidable teeth. Nothing can escape their deadly grip. Butterflies and other insects come to this lure for a draught of nectar. Their end is swift!

Some use lures of a more active type. The matamata water-tortoise, whose shell has been modified to form a series of bosses simulating stones lying at the bottom of the stream, lies in wait for small fish. As these approach, a long, worm-like tongue is thrust out, and given a wriggling motion. The fish respond to the tempting-looking bait, and are instantly engulfed by the inrush of water caused by the sudden opening of the mouth.

The angler-fish is an expert in the use of lures. The skin surrounding the huge mouth is, as it were, frayed out. Currents of water induced by breathing set the ragged fringe in gentle motion, attracting the attention of small fishes; or they are brought within range by the waving movement of a flap of skin borne at the end of a long rod formed by one of the rays of the dorsal fin, which has become split up into a number of isolated rods widely separated from one another, the foremost being situated immediately over the rim of the mouth. Attracted by

Oliver G. Pike

SITTING PARTRIDGE HIDES IN THE HERBAGE SURROUNDING HER NEST

The hen partridge, when sitting on her eggs, is difficult to find, as her brown and black plumage blends remarkably well with the tangle of grass and bramble round about, and the human eye is deceived. The camera, however, is able to pick out the detail. Were it not for this protective colouring birds with nests on the ground would be at the mercy of many enemies

M H Crawford

THE SWALLOWTAIL IS ALWAYS CONSPICUOUS

Most British butterflies that are brightly coloured on the upper side, have dull undersides, so that when they alight and close their wings they may remain unnoticed by enemies. The swallowtail is a curious exception, being brightly coloured on both sides

the foremost lure the fish come unsuspectingly to the very jaws of death, for the fisherman lies half concealed in the mud. When the victims are sufficiently close the mouth is suddenly opened, and with the consequent inrush of water the poor dupes are swept in.

It would almost seem as though these creatures were conscious of the benefits they derive from the likeness they present to their surroundings. Take the case of the spider-crab, for example. Here the body is made to match its surroundings, not by its natural coloration, but by fixing pieces of seaweed to bristle-like hooks which cover the shell and legs. Take a captive spider-crab, strip him of his covering, and pitch weed and crab into a large bowl of sea-water. Presently the captive will begin to place every scrap of weed back again. If, instead of the weed, small stones are thrown into the dish till the bottom is covered, the crab will fasten on the stones instead, till once more it matches its background.

The remarkable univalve molluscs, known as carrier-shells (*Xenophcriaes*), fasten to their shells pieces of coral, the shells or fragments of shells of other molluscs, and even those containing living occupants; while some of the hermit-crabs, in like manner, use live sea-anemones. When it becomes necessary to move into a larger shell the anemone is gently unseated, and placed on the new home to serve as a living mascot.

SOMETHING must now be said of creatures which can change their coloration with the most astonishing rapidity, not merely by the incidence of light falling upon prismatic surfaces, as in the case of the metallic feathers of the peacock, which at one moment may show green, the next blue, the next copper, for here the coloration is fixed, the changes are due to the effect of lighting.

The colour changes to which attention is now drawn are to be seen in their highest perfection in, say, the octopuses and squids, and some of the tropical fishes. And this because the pigments lie immediately under the outer surface of the skin.

They consist of little droplets of pigment, enclosed within a series of small, closed membranes or pouches, richly supplied with nerves and subservient strands of muscular fibres. The various pigment-sacs are attuned to respond to differing intensities of light received through the eye, as is shown by the fact that blind fishes make no colour change. By this mechanism trout, for example, are able to adjust their coloration to harmonise with the colour of the bottom of the stream in which they live. But this change is effected slowly. Very different is the case with the Nassau grouper of the Bermudas, shown in the photographs in page 29. In the upper figure it is seen as a dull lead-coloured fish, while below it is seen banded and marbled with pure white; and this change takes place within a few seconds.

Some of these tropical fishes display the most astonishing range of coloration, and captive specimens lose none of their ability for such transformation. Different individuals in the same tank will produce the most dazzling effects. Thus, a uniformly yellow fish will suddenly assume an orange tint on the back, and this will gradually deepen into brownish red, while the sides and under parts will become paler. At the same moment a greenish fish will suddenly flash out red. Another will change from yellow to deep bronze, striped with blue; and the stripes may change from longitudinal to vertical with the most disconcerting rapidity.

In these cases it is clear that the sudden changes

E. J. Manly

A FISH THAT CHANGES COLOUR

The Nassau grouper, a fish of Bermuda waters, is normally of a dull leaden colour, as in the upper picture, but under the stimulus of light it changes colour and, within a few seconds is conspicuously banded and marbled with white, as in the lower photograph.

are due rather to emotional than to light stimuli. But whatever the stimulus the effect is the same—at one moment all the pouches containing blue or yellow pigment are, as it were, squeezed flat, so as to spread their contents into a thin layer; while the bronze or the red pigment-pouches will contract to assume a spherical form like so many little pudding-bags, whereby the pigment is concentrated into a small, inconspicuous droplet, having no effect at all on the coloration.

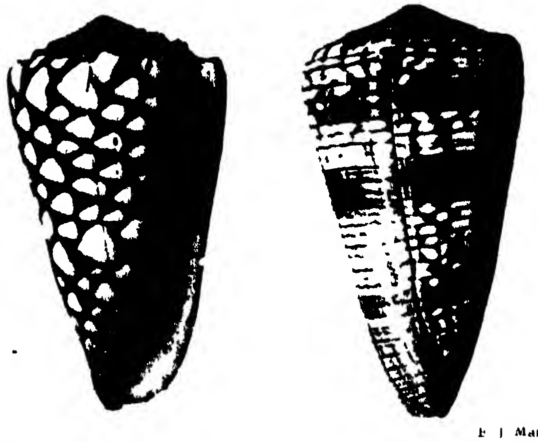
Let us pass now to the theme of warning coloration, the very antithesis of protective or concealing coloration. Always and everywhere it is associated with nauseous qualities. The evidence shall speak for itself. Perhaps the most convincing and most striking instance of this type is that furnished by the skunk of North America. This creature is most conspicuously marked with longitudinal bands of black and white. When alarmed, instead of seeking safety in concealment it ostentatiously parades before its potential enemy. Should this be a wolf or dog it waits until the oncomer is within a few feet, then suddenly turns its tail to the attacker and squirts, from glands near the base, a most virulent and evil-smelling liquid. Blindness may follow should it touch the eyes; and foaming at the mouth results from the smallest particle of this corrosive spray which may touch the tongue. Never again will that black and white demon be molested! Should the dog's owner, standing several yards off, receive the smallest particle of this spray on his clothes, they will be unwearable for weeks. So nauseating is the smell that in some people it induces fainting.

There are several species of skunk, differing one from another in size, as well as in markings, but in all of them, these markings consist in strongly contrasted areas of black and white. A precisely similar warning livery is worn by the African zorillas, and the Cape pole-cat; and these, in like manner, discharge from glands at the base of the tail an acrid liquid having a most repulsive odour.

Emphasis must be laid on the fact that all these creatures, though technically carnivores, feed upon insects, worms, roots, and fruit, as well as on mice, frogs, lizards, and so on. Hence they are not dependent on concealment for the capture of lively prey. In this it is important to note that they differ conspicuously from their near relations the stoats, weasels, and martens, which are wholly carnivorous, and protectively coloured.

Black and yellow and black and red are common types of warning coloration. The hornet and wasp are familiar examples of the black-and-yellow types; and there is no need to stress the power of these insects to inflict punishment on the unwary. The black-yellow salamander, though powerless to injure man, is effectively protected against aggression by animals which seize their victims in their jaws. For the salamander when taken into the mouth exudes from glands on each side of the back of the head an acrid juice. One such lesson suffices.

The small toad known as the fire-bellied toad presents a very singular form of warning coloration, since when at rest it is protectively coloured. But when alarmed it throws itself upon its back, revealing great blotches of black and red. Some of the South American tree-frogs of the genus Dendrobates, display warning colours in great variety. Some are black and white, some black and red, some black and yellow, while one is vermilion coloured with dark patches on the back and legs. All, however, are highly poisonous. This fact is well known to the natives, who apply this poison to the tips of their arrows when shooting monkeys. Thus introduced



E. J. Manly

SHELL MARKINGS SEEN ONLY AFTER DEATH

The conspicuous markings of the cone shells, two examples of which are given here, are familiar to all but when the mollusc that inhabits this type of shell is alive the pattern is quite invisible, being covered by skin, which perishes at death and lays bare the pattern

into the victims' blood-system the heart and central nervous system are swiftly deranged, and they fall helpless to the ground. It is also worth noting that the only lizard possessing poison fangs, the gila monster or heloderm lizard, is coloured black and red.

Experiment has shown that the gaily coloured caterpillars, like the black-and-yellow larvae of the cinnabar moth, are never eaten by birds save in the direst need. Throw a number of protectively coloured and warningly coloured caterpillars to the fowls in the farmyard, and watch the result. All will be instantly snapped up, save the black-and-yellow-coloured. If any of these do happen to be seized they are quickly dropped.

The remarkable facts which have been embodied to form the theory of mimicry are intimately associated with warning coloration. The phenomena are best exemplified among the butterflies, which, indeed, led to the discovery of the strange facts about to be described.

The traveller-naturalist Bates, collecting natural history specimens on the Amazons more than half a century ago, was struck by the singular uniformity in the coloration of the butterflies at each of his several halting-places. However varied their patterns, when the collection was seen as a whole, the colours were always the same—black and yellow—colours, be it noted, associated with nauseous qualities. It was not until he began to study his spoils at leisure, after his return to England, that he solved his puzzle.

THE most numerous forms were always some species of Heliconias, a broad-winged, slow-flying insect; like the skunk, indeed, advertising the fact that all who attacked would do so at their peril. All the remaining butterflies were of different genera, belonging to the Pieridae, to which our cabbage-white belongs. There could be no mistake, because the venation of the wings, and other deep-seated characters, which distinguish the Heliconias and the Pieridae, are quite distinct. The Pieridae had, in short, completely disguised themselves by assuming the coloration of the Heliconias. And, in so doing, they masked the fact that they were really edible species by assuming the guise of the nauseous species. This type of mimicry is known as Batesian mimicry, to distinguish it from an even more remarkable form of this subterfuge known as Mullerian mimicry, from the discovery by the naturalist Muller, that the various species of the genus Heliconias were closely mimicked by as many species of the equally inedible genus Melanitis. He then showed that this common likeness conferred an immense advantage on all the species concerned, since it would spread the incidence of attack from inexperienced birds, and other foes, over the whole community, and it would at the same time immensely reduce the number of such attacks. For if the several species differed, one from another, in coloration each would have to bear the brunt of experiment.

Our own bee-hawk and clear-wing moths furnish us with good instances of Batesian mimicry, for they bear a most uncanny likeness to bees, hornets, and wasps. And to effect this, too, they have to rid the wings of their scales, to make them transparent. The innocuous hover-flies, so common in our gardens during the summer, bear a striking likeness to bees.

It is not to be supposed that these creatures consciously assume the coloration of the inedible species. The likeness, to put it briefly, has come about through the agency of natural selection, whereby any variation towards the coloration of the inedible gave the variants a better chance of escape from their enemies than the more conservative individuals. Doubtless it has taken an immense time to bring about these results, but Nature is never in a hurry.

Throughout the animal kingdom we find marked differences in coloration between the sexes. Nowhere is this more apparent than among the birds, and nowhere can the facts associated therewith be so easily studied. The inferences to be drawn therefrom will be found to apply with almost equal force in regard to other groups.

THIS survey must of necessity begin with species in which male and female are coloured alike, and of relatively sombre hues as, for example, in the wren. Where any advance in the direction of a resplendent dress is found it will be noted that it starts with the male, as in the case of the common sparrow.

When all the evidence comes to be surveyed the conclusion seems to be irresistible that the evolution of a resplendent dress was at first an evanescent, seasonal phenomenon, due to the activities of the reproductive glands at the time of the spring moult; as, for example, in the case of that remarkabe member of the plover tribe, the ruff. At the autumn moult he sheds his splendours and assumes again a plumage like that of his mate.

That foundation once laid there grew up a tendency to retain the resplendent or nuptial plumage for longer and longer periods, till at last it becomes the permanent livery of the male. The mallard is a good illustration of this phase. For he wears his ancestral dress, resembling that of the female, for no more than a few weeks. The cares of a family have hardly begun—and he leaves these to her—than he goes into eclipse, assuming a livery often confused with that of the female, and at this time he is flightless, owing to the fact that all the quills or flight feathers are moulted at once, instead of in pairs as is the rule among birds. Being flightless, the protection afforded by his concealing coloration is all-important.

By the late summer the new quills have hardened, and he then proceeds to moult again, resuming the characteristic resplendent dress we know so well. In some of the game birds, like the blackcock, no more than a vestige of this ancestral "female" dress remains, for its last traces are seen in the head and neck, which, for a short space, stand out in sharp contrast with the rest of his plumage, since they are coloured like that of the hen. In *Gallus*, the neck hackles are for a short space discarded. In the pheasant the resplendent dress is never lost.

THE LIVING RAINBOW OF ANIMAL COLOUR

A Key to all the figures in this plate follows the chapter on Animal Coloration, on page 31

Presented with Part One of WONDERS OF ANIMAL LIFE

The purpose of this plate is less to depict the individual creatures than to illustrate in an

To face page 30

The gorgeous birds of paradise for a short space are hen-coloured, and this is true also of many brilliantly coloured weaver finches and tanagers, which wear two distinct liveries known as the winter and summer plumages. These changes are often striking, as in the scarlet tanager which has a summer or nuptial dress of scarlet and black but in the winter a dress of green and black.

The next phase in the evolution of a permanently resplendent dress is seen where the female acquires the like splendours of her mate, leaving the ancestral, sombre dress to the young, as in the case of our starling. Finally, we have the case of the kingfisher where male, female, and young are all resplendent. But much is yet to be known. Why, for example, is the house-sparrow resplendent, after his fashion, leaving the drab hues to the female and young, while with the tree-sparrow, not only the male, but female and young are all resplendent?

In this brief chapter it has been impossible to do more than trace the broad outlines regarding the coloration of animals and its significance, but enough has been said to show what a fascinating theme it is.

Martin Duncan

INSECTS SHAPED AND COLOURED LIKE LEAVES

The leaf-walking insect, two examples of which are given in this photograph, is a native of India. It cannot fly for it has no true wings, but the wing-cases are shaped like a leaf and the colour varies according to the foliage it frequents.

The Living Rainbow of Animal Colour

The large three-fold colour plate facing the preceding page is not intended as a scientific contribution to the subject of Animal Coloration which Mr. Pycraft deals with in Chapter III. It has been designed chiefly to illustrate in a novel, yet accurate, manner the fact that all the colours of the rainbow are also displayed in animal life.

The animals have been skilfully grouped by the artist along the respective colour bands of the rainbow to which their predominant hues most nearly correspond. The result is at once pleasing and instructive, and the editor doubts if so large a variety of birds, beasts, fishes, reptiles and insects has ever been represented so effectively in the same space.

There are in all 197 figures (naturally, relative sizes could not be shown), and below a complete key-list is provided, numbered in the order of the colours from left to right The scientific names are given only in those cases where no popular ' names are available. Typical black and white and grey animals are shown in the right bottom corner of the plate

RED: 1, Coccinella septempunctata; 2, Cardinalis Cantharis; 3, Xanthospilopteryx superba; 4, Zygaena filipendulae; 5, Cantharis Nuttalli; 6, Ampelis carnifex; 7, Rhamphocelus ignescens; 8, Rhomalea; 9, Cardinalis Virginianus; 10, King Bird of Paradise; 11, Cardinal Lory; 12, Cock of the Rock; 13, Red and Blue Macaw; 14, Crimson-breasted Barbet; 15, Golden Pheasant; 16, Banded Snake; 17, Pterois miles; 18, Streaked Gurnard; 19, Golden Red Perch; 20, Actinia chiococca; 21, Sun Star; 22, Giant Crab of Japan; 23 and 25, Actinia mesembryanthemum; 24, Red Coral.

ORANGE: 1, Orange-tip Butterfly; 2, Hypotrabala Neavei; 3, Curculio brunnens; 4, Callioratis Millari; 5, Large Copper Butterfly; 6, Phromnia rubra; 7, Horia maculata; 8, Miniodes discolor; 9, Arctia caja; 10, Danais archippus; 11, Giant Swift Moth of Australia; 12, Arctia caja L.; 13, Blue-breasted Lory; 14, Short-billed Minivert; 15, Toto Toucan; 16, Sappho sparganura; 17, Orange Fruit Pigeon; 18, Selatophorus rufus; 19, Rhamphastos maximus; 20, Xanthornus aurantius; 21, Weaver Bird; 22, Gila Monster; 23, Solverenus; 24, Amphiprion Cicinctis; 25, Bunodes coronata; 26, Balanophyllia regia; 27, Comet Goldfish; 28, Spinous Cockle; 29, Stomphia Churchiae; 30, Sagartia troglodyte; 31, Orange-disk Anemone; 32, Pecten opercularis; 33, Mauritius Star Fish.

YELLOW: 1, Brimstone Butterfly; 2, Niasia difformis; 3, Opisthograptis luteolata; 4, Cassida micans; 5, Clouded Yellow Butterfly; 6, Geana sulphurea; 7, Madagascar Giant Moth; 8, Blue and Yellow Macaw; 9, Muscicapa chrysomela; 10, Black-tipped Sulphur Butterfly; 11, Zygaena filipendulae; 12, Golden Oriole; 13, Paradisea apoda; 14, Golden Conure; 15, Heniochus macrolepidotus; 16. Beaked Chaetodon; 17, Gemmous Dragonet; 18, Camel; 19, Cystagnathus Senegalensis; 20, Salamander; 21, Jaguar; 22, Leopard; 23, Giraffe; 24, Antilope scripta; 25, African Fennec; 26, Tiger; 27, Lion.

GREEN: 1, Polyommatus Endymion; 2, Curculio Latreillii; 3, Great Green Grasshopper; 4, Ityraea electa; 5, Cantharis vesicatoria; 6, Molachius marginellus; 7, Buprestis bicolor; 8, Cassida bicornis; 9, Enchloron megaera; 10, Ornithoptera Priamus; 11, Puss Moth Caterpillar; 12, Swallow-tail Butterfly Caterpillar; 13, Emperor Moth Caterpillar; 14, Oleander Hawk Moth Caterpillar; 15, Leaf Insect; 16, Pseudochalcothea auripes; 17, Mantis; 18, Chameleon; 19, Livingstone's Turaco; 20, Rana esculenta; 21, Ceratophrys ornata; 22, Green Lizard; 23, Australian Frilled Lizard; 24, Alexandrine Parakeet; 25, Budgerigar; 26, Glossy Starling; 27, Trogon pavoninus; 28, Psittacus aestivus; 29, Pionus menstruus; 30, Green Woodpecker; 31, Peacock; 32, Actinia mesembryanthemum; 33, Sagartia troglodytes; 34, Sagartia chrysosplenium; 35, Globe Fish; 36, Kelloggella cardinalis; 37, Rainbow Leaf-worm.

BLUE: 1, Apoderus ruficollis; 2, Curculio sexdecimpunctatus; 3, Rhynchites pubescens; 4, Calopteryx splendens; 5, Neurobasis; 6, Morpho cypris; 7, Adonis Blue Butterfly; 8, Desmocerus cyaneus; 9, Calopteryx virgo; 10, Orthetrum cancellatum; 11, Oedionychis cincta; 12, Coris aygula; 13, Polyommatus venus; 14, Polyommatus marsyas; 15, Erycina melibaeus; 16, Physalia pelagica; 17, Abudefduf Leucopomus; 18, Garfish; 19, Blue Wren, 20, Caereba cyanea; 21, Blue Creeper; 22, Pica colliei; 23, Small Racquet-tailed Kingfisher; 24, Lanius bicolor; 25, Ampelis cotinga; 26, The Blue Bird; 27, Common Kingfisher; 28, Hyacinthine Macaw; 29, Blue Tit; 30, Edolius coerulescens, 31, Indian Black naped Flycatcher; 32, Blue Bird of Paradise.

INDIGO: 1, Victoria Crowned Pigeon; 2, Tectocoris Banksii, 3, Blue Crossbeak; 4, Lyrurus tetrix; 5, Mikado Pheasant; 6, Pelrossirus atrodosalis gunther; 7, Geotrupes stercorarius; 8, Scincus caelestinus; 9, Oceanops Latorittata; 10, Brachyluphus fasciatus; 11, Cychlae fasciata; 12, Gomphosus coeruleus; 13, Blue Shark; 14, Sailfish

VIOLET: 1, Ianthina globosa; 2, Australian Star Fish; 3, Sea Slug, 4, Purple and Gold Bird of Paradise; 5, Violet Plantain Eater; 6, Purple Hairstreak Butterfly; 7, Goliathus magnus; 8, Rhinoscapna Bennetti; 9, Mouhotia Batesi.

WHITE. Polar Bear, Arctic Fox, Stoat, Ptarmigan.

GREY: Grey Falcon, Grey Parrot, Striped Hyena, Indian Buffalo, Boatbill, Grey Lag Goose, Peccary.

BLACK AND WHITE: Malay Tapir, Ostrich, Zebra, Porcupine, Guereza Monkey.

BLACK: American Black Bear, Raven, Black Panther, White-handed Gibbon.

THE GIANT DRAGON OF KOMODO, MOST STRIKING OF ALL THE LARGER REPTILES

It is only within recent years that the great lizards living on the East Indian island of Komodo have been proved realities. For generations the natives of adjacent islands told tales of great and fearful dragons that lived at Komodo, their terrified imaginations magnifying the sizes of the monsters till they were supposed to be between twenty and thirty feet long. Many people, however, were sceptical about their existence till 1912, when an expedition went out and actually found these huge lizards. Monsters were seen as long as fifteen feet. Some of the dragons were caught alive, including the one shown here with its tongue projecting and brought to the London Zoo, where their habits are now being carefully studied.

Chapter IV

Dragons That Are Alive To-Day

By Joan B. Procter, F.Z.S., F.L.S

Curator of Reptiles to the Zoological Society of London

The thanks of the Editor are due to Miss Procter for enabling him to publish the unique series of illustrations of the Komodo lizards under her care at the London Zoo, these photographs having been specially taken by Mr. F. W. Bond for WONDERS OF ANIMAL LIFE. For the illustrations which appear in pages 38 and 39 and the lower photograph in page 35, he is indebted to the courtesy of the American Museum of Natural History, New York.

To the minds of many people, the word dragon suggests a purely mythical beast ranking with the phoenix and the unicorn. They think of winged serpents, and if they happen to be reporters writing articles on the real dragons at the Zoo, they cannot resist at least one reference to St. George! In other words dragons are relegated to the past; to art, mythology, and the world of imagination. And yet almost all fictitious dragons are based on living reptiles, usually lizards, but sometimes giant pythons and crocodiles. Some are actual reptiles which I shall describe, and others composite beasts made up on the "Makara" principle, like the nursery game, "Head, body, and tail."

In the East there are several lizards with crests, wattles, and other decorations, and those of the genus *Draco* have brilliantly coloured wings with which they can volplane from tree to tree. Their wings are supported by prolonged ribs, and superficially resemble those of butterflies. These lizards also have gular sacs, and if they were not small in size would be very impressive.

Another species which resembles the Chinese dragon, is *Phisignathus cochinchinensis*, which is found in Siam, Annam, and Cochin China, and which is also very beautifully coloured and crested.

It happens, however, that the dragon of the Dutch East Indies, so much dreaded by the natives, is a genuine creature, a colossal monitor-lizard living on Komodo Island, which lies between Sumbawa and Flores, in the Lesser Sunda Islands.

But although only lizards, and not even prehistoric, they are quite equal to the dragon of fable. They are certainly the most powerful living lizards, with wonderful muscles and large heads, limbs, tails, claws, broad snouts, red mouths, long, forked, snake-like yellow tongues, strong recurved teeth, brilliant eyes; and perhaps a quality that is more important than the rest: a curious dignity, given to them by the regal way in which they hold their heads and carry themselves as they move about.

The skin is coarsely scaled and very delicately shaded in several colours. They are always described as brown, but this is only the general effect, caused by the fact that each scale has a brown spot almost reaching to its edge. But the skin itself is almost carrot-orange on the shoulders and back, and lime-green on the neck and chest, and black predominates on the head and limbs. The general effect is mainly chestnut, with brighter shades on the front part of the body, and darker limbs. The upper eyelids and long, thin tongue are pale yellow.

Naturally, as the lizards grow older, the juvenile colours give way to dull browns and blacks, but the description in this chapter is based on two healthy seven-feet specimens which cannot be said to be very young, and the pair have grown noticeably brighter as they have become healthy and contented, although one would not have expected their coats to improve to such an extent in captivity.

There is no doubt that this monitor is the most striking of all the larger reptiles. The natives call it *Boeaja darat*, or land crocodile, and herpetologists, or reptile students, have compared it with *Tyrranosaurus* and many other prehistoric monsters. It was discovered to science as a reality only recently, and was first described in 1912 as *Varanus komodoensis* by the zoologist Ouwens, who sent collectors to Komodo to search for the lizards, because certain pearl-fishers had corroborated the dragon stories of the natives of the adjacent islands. Five specimens were killed for him, the largest of which measured about nine and a half feet. At this time the species was thought to attain a length of at least 23 feet, but now that we know more about it, it seems probable that 15 feet is about the maximum.

Then in 1926 the American Douglas Burden Expedition went to Komodo and explored the island and rounded up many dragons, the largest of which was just over nine feet. The principal object of the expedition was to get material for a dragon 'group' for the New York Natural History Museum, and for this they brought back twelve dead specimens together with masses of useful photographs of the lizards in their natural habitat. They also brought two live specimens for the Bronx Zoo, which, however, soon pined to death. Burden says of these, "It was painful to see the broken-spirited beasts that barely had strength to drag themselves from one end of their cage to the other."

We now come to the much happier dragons in the New Reptile House at the London Zoo. They arrived on Whit Sunday, 1927. We christened them Sumba and Sumbawa, and they are now almost as well known and as much photographed as Douglas Fairbanks and Mary Pickford.

They were obtained for us by Dr. Malcolm Smith, the herpetologist, to whom they were sent by the Governor of the Dutch East Indies, and as soon as we knew that they had been shipped we began to arrange a perfect home for them in the new house.

Their enclosure contains a cave, electrically heated rocks, a swimming pool, growing palm-trees, over-

head heat-beam radiators and ultra-violet artificial sunlight lamps, focussed in parallel, vita-glass lights, and other arrangements, which, working together, produce a miniature Komodo, with correct climate and surroundings.

Owing to the enormous strength of the lizards, the ceiling apparatus had to be protected by steel bars, and the lower portions of the partitions are disguised sheet metal. We also provided four doors, one in each corner of the enclosure, for the safety of keepers, because, according to the American accounts, the dragons might be expected to be ferocity personified.

When the dragons arrived, they were ill and miserable; so we gave them warm baths, drinks, and medical attention. It is not possible to give their correct lengths, as both of them have lost quite six inches of tail, but they are about seven feet each, and weigh approximately between four and a half and five stones. They differ from *Varanus salvator* in almost every particular, but chiefly in relative bulk, for in head and body they are more than twice as large as a seven-foot *V. salvator* in our collection. In the latter somewhat slender species, quite two-thirds of the total length is tail, as against barely one-half in the very powerfully-built *V. komodoensis*. It is almost certainly this fact which has given rise to the stories of their gigantic size, for estimating upon the lines of better-known species, one would get entirely wrong figures.

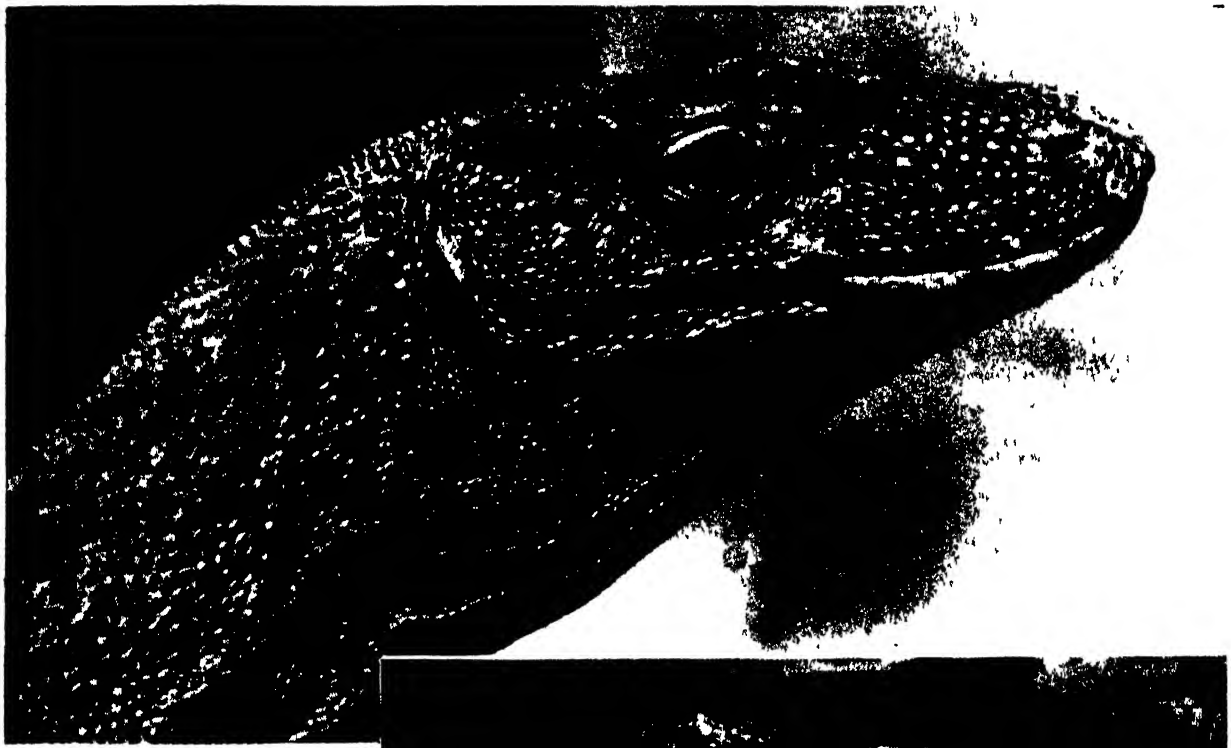
Further, Dr. Dunn, who was with Burden, says that when the lizards are tracked and watched in their wild state, they give quite an overpowering impression of size, so much so that as each lizard was shot its actual measurement was invariably a surprise and disappointment. Moreover, they carry themselves with such dignity, and are so muscular, that even half-grown specimens must appear alarming to people who do not understand reptiles. Mrs. Burden was evidently terrified by them, for she writes: " The creature was now less than five yards away, and its subtle reptilian smell was in my nostrils. Too late to leap from hiding. If I did, he would surely spring upon me, rending me and devouring my remains as he had devoured the dead deer."

Yet Sumbawa can be trusted with small children!

In fact, almost everything that has been written about these dragons proves to be inaccurate. After the opportunity of studying the lives and domestic

A "CLOSE-UP" OF THE GIANT LIZARD, SHOWING THE MUSCULAR DEVELOPMENT OF ITS FOREQUARTERS

Seen in this fore-shortened position, the Komodo monitor looks as formidable as any dragon of the story-books, yet its keeper can lead it about as tamely as Saint Martha led the monster Tarasque in the legend of Tarascon. This photograph very clearly illustrates the immensely strong neck and breast muscles and powerful forelegs The skin of these huge lizards, which is covered with scales, is in their earlier years delicately shaded in several colours. They have been kept so ingeniously in their London captivity that they are now perfectly healthy.



DRAGON'S JAWS THAT CAN BITE THROUGH SOLID METAL

These photographs afford some idea of the massive heads and muscular jaws possessed by the great lizards of Komodo. They can even bite through metal, and yet during the whole time that the dragons have been at the London Zoo they have never attempted to snap at a human being. The long yellow bifurcated tongue, like that of the snakes, is used as a sensory organ

routines of our now perfectly healthy, spirited, and normal Sumba and Sumbawa for over 15 months, it seems amazing that so much nonsense should have found its way into scientific literature! One of the worst items is that the species is described as stone-deaf, when in actual fact they have the same sense of hearing as the other members of the genus.

Of course, it is very difficult to test the hearing of wild animals, but the fact that they frequently take no obvious notice of sounds is no proof whatever that they are deaf. On Komodo Island what have they to fear, and consequently to listen for? The only large mammals are buffalo and harmless deer; all other creatures on the island, such as pig, and smaller mammals, water-fowl, smaller monitors, and so on, are preyed upon by the dragons, who hunt by sight and smell. Experiments show, however, that our Sumba and Sumbawa will turn their heads sharply when called now that they have learned to associate the call with food, but, of course, only if they are hungry, and if they feel in a responsive mood. I have on these occasions taken great care that they should not catch sight of me, or pick up vibrations of footsteps. If you take a Siamese cat, as another example of a protected animal of independent character, you will find that it will not so much as turn its head when you speak to it, unless it happens to feel in the mood; why should it? And if you call to it to come in when it is stalking birds, it will not pay the slightest attention to you, and yet who would dare to say that cats are deaf? The behaviour of these lizards cannot be construed on the same lines as that of domestic dogs, or timorous antelopes.

Then there is the question of the way the eyes are described, and also portrayed in the stuffed specimens, as beady. The living lizards have large, very bright, and gentle eyes, like the eyes of Alsatian wolf-dogs. And the upper lid is not at all flattened or beetly, but rounded, and of a pale lemon yellow, like the long lithe tongue.

POWERFUL AND FEARSOME REPTILES THAT ARE AS GENTLE AS LAMBS

Although many stories have been told of the ferocity of the giant lizards of Komodo, their dragon-like form, huge size, and voracity seeming to lend confirmation to such reports, yet a close acquaintance with two of the reptiles at the London Zoo has quite discounted this estimate of their character They like to be stroked and patted. The Curator of Reptiles at the Zoo takes one of the dragons with her when she goes on a round of inspection. As seen in the lower photograph the dragons carry themselves with great dignity, a fact that seems to impress all who see them.

THE DRAGON SWALLOWS A CHICKEN WHOLE

The giant lizards of Komodo in their native haunts seize pigs and small deer for food but in London they are fed chiefly on fowls and eggs. The lizard swallows a fowl whole in two gulps its great mouth opening wide enough to take the bird, as seen in the lower picture. Its jaws are very powerful and once, when being given an egg in an iron table spoon, it bit off the bowl

The question of the ferocity of these lizards is, perhaps, the most misunderstood of all. All the lizards of the genus *Varanus* are savage, predatory, and highly strung, and they use their teeth claws and slashing tails with great effect, as I have personal cause to know. At the Zoo we consider any large monitor more dangerous to deal with than a crocodile twice its size. But, allowing for this, *V komodoensis* is the gentlest, most intelligent, and most tractable of them all. This is comparing them with specimens only half their weight of species such as *niloticus albigularis*, *bengalensis salvator*, *nebulosus*, *varius* and so on. It is quite true that they are very nervous, and also that they could no doubt kill one if they wished, or give a terrible bite when taking food from the hand greedily but there is no vice in them.

Sumba is the more nervous of the two, and if he is meddled with or bothered, as for instance if one picks ticks off him, or if he is frightened, he will turn at bay and open a large red mouth. He also slashes with his tail, but on the other hand he takes food from our hands and will sometimes permit his head to be stroked and his back scratched. Sumbawa, the heavier larger dragon has never attempted to bite at all, even though she has had to submit to surgical dressings, cauterization of septic tick bites, and daily dental treatment. The more treatment she receives the more tractable and gentle she becomes.

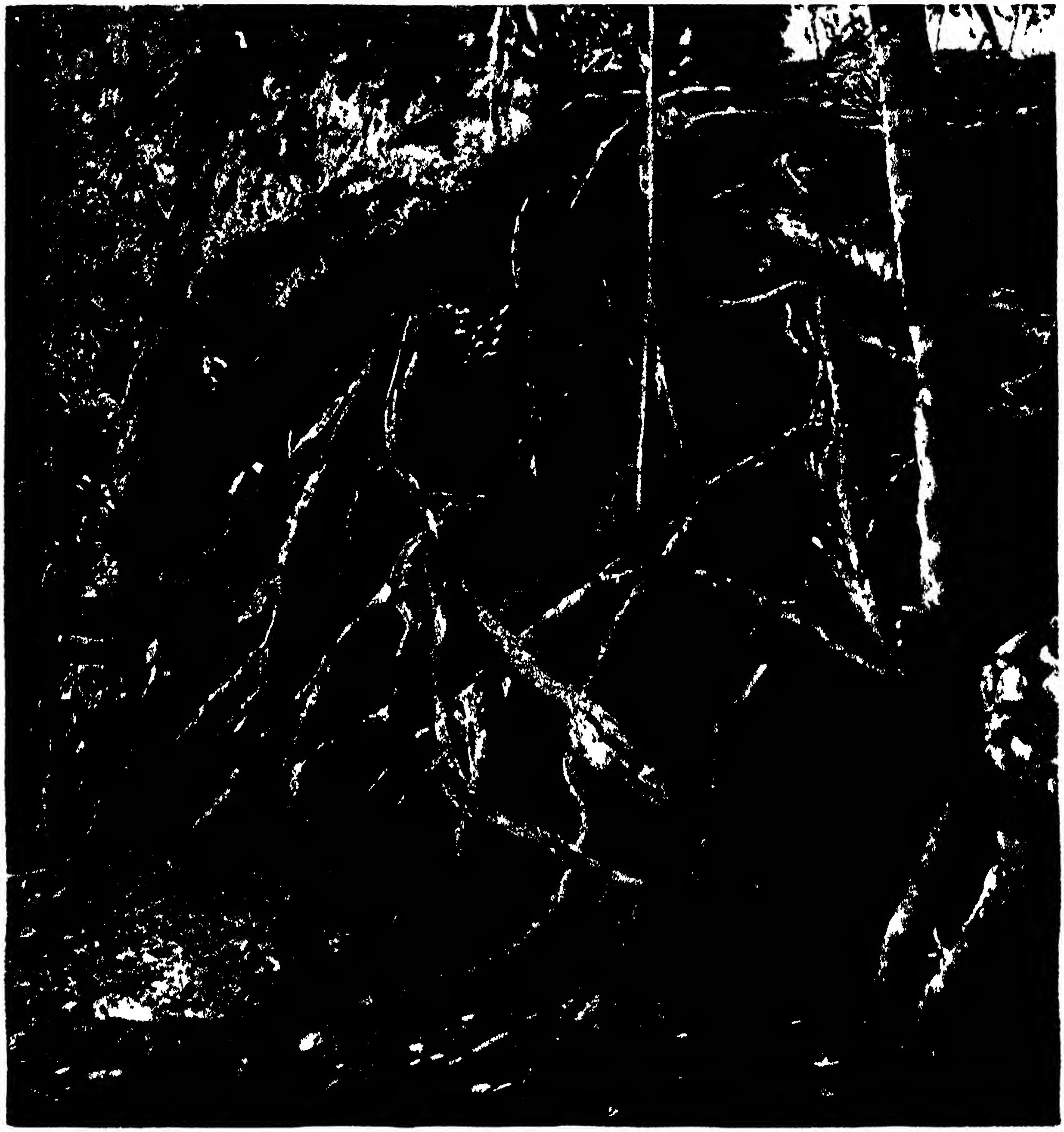
TELEPHOTOGRAPHIC IMPRESSION OF TWO OF THE LIZARDS OF KOMODO FORAGING FOR FOOD IN THEIR NATIVE HAUNTS

This picture, reproduced from the touched up print of an instantaneous photograph taken on the Island of Komodo by the Burden Expedition, is not offered as a faithful reproduction of the dragons in detail; but it has definite value as illustrating their movements in pursuit of food. Having been "snapped" at a distance in unfavourable light, the details of the original photograph are necessarily indistinct, though the general impression of the scene and the motion of the reptiles are graphically conveyed.

When they first arrived they both required a great many painful dressings, for they had canker of the jaw, injured tails, septic paws, torn claws, and abscesses. Now, however, they are very well, greedy, and generally fit. There is nothing of the craven captive about either of them, and there is also no question of their being sluggish, for they have a tropical climate, and about eight hours of artificial sunlight each day. Sumbaw comes for daily walks with me on my rounds of inspection, investigating everything that might be of interest.

She has no objection to my holding the end of her tail and using it as a rudder, and she is good at walking up and down stairs. Only a few weeks after her arrival she gave a children's tea-party, and she does not mind small children bullying her. Except when she is actually bolting food, she is absolutely safe. When she is in a tiresome mood one can wrestle with her, and she will struggle like a naughty child and persist in what she is doing, but she never bites or attacks. Of what other reptile of that or any other weight can this be said? For one must always remember that it is certainly true that these monitors do tear down pig and deer and swallow large fowls in two gulps. Certainly I dare not touch our large *V. salvator* without two men to help. But *V. komodoensis* has the natural temperament of a nice large dog, and I am not quoting from our own London Zoo dragons alone, for I have just heard that one has arrived in Berlin, and that this specimen is also really gentle with human beings.

Like most intelligent creatures they have varying fancies about food. Sometimes it is large fowls and at others vast quantities of eggs, each one carefully picked up whole. Both Sumba and Sumbawa will take an egg off a spoon



"THE HABITATION OF DRAGONS WHERE THEY DWELL"
The great monitor lizards of Komodo make homes for themselves among the rocks of their East Indian island by digging out the earth with their powerful claws. Selecting a place sheltered by trees they scratch away the soil till the roots are exposed, and into the den thus formed they crawl when darkness falls and remain under cover all night. Then, when morning breaks, they come out and prowl among the rocks for food, seizing any unlucky mammal or bird that comes their way. Their dens can accommodate two or three men

very neatly, but to give some idea of the strength of their jaws it must be added that once Sumbawa bit the spoon off the handle along with the egg, and it was a very stout metal tablespoon! Sumba, having grasped the fact that his mate gets more food than he does by coming out among the public, has now become a "gate-crasher," which is a little tiresome, because his manners are not so reliable. So now that we are in a position to understand the psychology of these terrible dragons we are more surprised with them than ever. But personally I prefer to enjoy their friendship in London, and not to visit them on Komodo for the purpose of trapping and shooting them. On the whole, two healthy living specimens teach far more about the species than many dead ones stuffed. And as even dragons are mortal, the British Museum will ultimately receive their bodies for morphological research.

Chapter V

The Amazing Story of the Common Eel

By E. G. Boulenger

Director of the Zoological Society's Aquarium

Of the many solid achievements which the present age may count to its credit, the solving of the eel mystery may be considered as one of the most important, involving as it does not merely the unravelling of the life history of an individual animal, but marking an epoch in deep sea exploration and economic oceanography.

The eel's sudden appearance in vast numbers and its equally sudden disappearance, its presence in isolated waters far from the sea or rivers, these facts among others baffled the best scientific brains for centuries. Not that the tale is even now altogether told. The newly-laid eel's egg, if it is laid at all, has not yet been discovered, nor has a wholly-ripe female eel, that is, one containing mature eggs.

So late as the latter part of the seventeenth century, when man had fairly set out to map the world and catalogue its treasures, this fish, abounding in home waters, was the subject of conjectures and learnedly-propounded theories that to-day merely provoke our mirth.

Izaak Walton, writing in 1653, says: " Eels growing old breed other eels out of the corruption of their own age, which exceeds not ten years. As, also, worms are made of glutinous dew-drops which are condensed by the sun's heat, so eels are bred of a particular dew falling about May or June on the banks of ponds and rivers." Eels were likewise supposed to be generated from horse-hair, straw, and so on, after prolonged saturation in fresh water.

It must be borne in mind that the trawl and all other complex apparatus at the command of modern investigators were as yet not even contemplated It was known, however, that eels were often, as they still are, dug out of the mud and even brought to light by the plough far from any water. The various-coloured varieties were known, and also the fact that the adult fish might often be caught hurrying seawards. Further, the elver fishing of the Severn and many other rivers was a much-looked-for event. Millions of tiny little elvers about the thickness of a straw were caught at the surface in the spring, being netted or even baled out with pails and blankets, and such fry were converted into cakes. Eel fairs, though now on the decline, still exist in certain districts, but to-day the bulk of the home supply comes from the Netherlands.

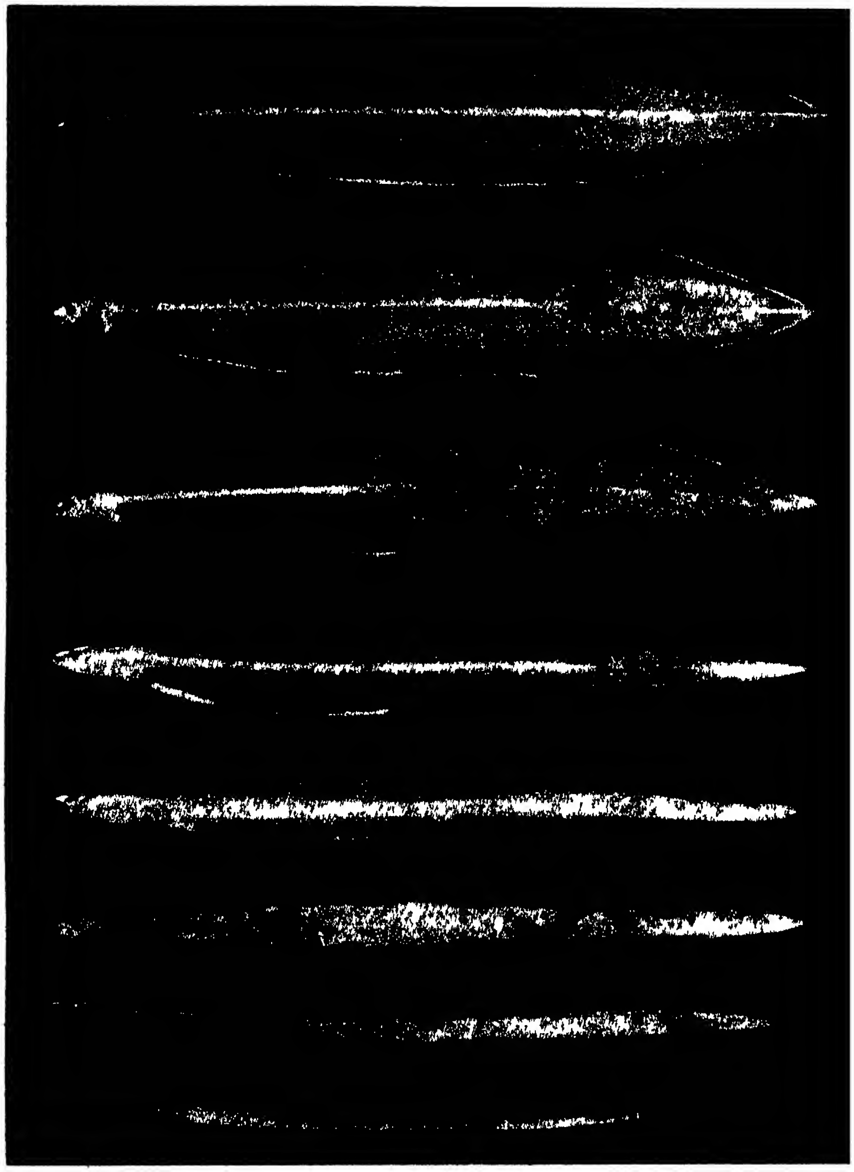
Early marine biologists of all countries have recorded captures of the glassy, transparent creature termed a leptocephalus, or small-head. The first taken in British waters was caught near Holyhead in 1763. Some of the specimens captured later were kept alive long enough for them to undergo some startling changes before metamorphosing into a juvenile eel. Their eyes became much smaller, their teeth fell out, the whole creature became opaque, and cylindrical instead of compressed and leaf-like. Such experiments cast a flood of light upon the entire eel question, and the next problem presenting itself was whence came the leptocephali.

This was a harder proposition, since it could only be solved upon the high seas. Two Italian investigators in 1893 found large numbers in the Straits of Messina, but no trace of them outside the Mediterranean. At this point progress came to a halt until 1904, when the Danish Fisheries Board began investigations, and Dr. Johannes Schmidt succeeded in capturing off the Faroe Islands a leptocephalus seven and a half centimetres long, or roughly three inches, a form known by the laboratory researches to be the larva of the common European eel.

COMMON EEL IN ITS SILVER LIVERY

The common eel changes colour several times during its life. When it first appears in our rivers it is olive green. As it grows this changes to olive brown, and when its breeding time arrives it assumes a silver livery, such as it is wearing here.

From this point onwards investigations proceeded apace. The seas were scoured for leptocephali from Iceland to Morocco. Such a task was obviously impossible for a single ship, and numerous commercial trawlers and cargo vessels were enlisted to help with the work. These towed small fish trawls at varying depths, from the surface to near the sea-floor, for several hours a day, carefully preserving the catch, with date, position, temperature, and other necessary data. As a result it was established that the eel larvae decreased in size from east to west, but at the



EIGHT STAGES IN THE EARLY LIFE OF AN EEL

In this picture, for which we are indebted to Dr. Johannes Schmidt of Copenhagen, we are shown various stages in an eel's early life. Born deep down in mid-Atlantic it is first of all a tiny leaf-like creature as thin as paper. Gradually it becomes more cylindrical, till at last it is like the bottom specimen here, and then begins to make its way across the sea to the rivers

same time increased in numbers, and the pursuit of the leptocephali led the investigators further westward.

It was in the neighbourhood of Bermuda that they were found to mingle with those of the nearly-related American eel, but the two species were never found together east or west of a prescribed area. The American eel larvae, for instance, were only taken between the West Indies and the mainland. Careful records of the young eels caught further established the fact that the American eels grew much more rapidly than the European.

From early spring to late summer the eels of the two hemispheres congregate in countless hosts in deep water in the western Atlantic, where one can only assume that the parents die. In their stead arise millions upon millions of leptocephali of two species differing from each other only in obscure details.

The American eels at once head westward and in a year reach the coast and proceed to the interior via the rivers. The European eels make east, at first travelling not far from the sea-floor, but rising by easy stages as they head for their goal, a three years' journey beset with innumerable perils. Only a small minority of those hatched survive the ordeal. In the course of their progress young eels eat everything within their compass, chiefly the minute floating plants and animals termed collectively plankton—young jellyfish, sea squirts, molluscs, crustaceans, and fish. This minority of surviving eels, forming at times a huge expanse of glassy appearance, drifts ever eastwards. Gulls attack the swarms from above, while flying-fish, mackerel, and other surface swimmers likewise take their toll. Yet, even after three years of steady persecution the hosts of infant eels colour the estuarine waters as they forge their way inland.

By this time a subtle change which began when the larval eel left the breeding grounds is almost completed. The body is snake-like in form, and of a dull, olive green. The appetite steadily increases, and larger and still larger animals come within its scope. No river is safe from the incursions of the growing eel. With the advent of its first winter it haunts the lower waters, eventually coming to rest on the river-bed. Winter finds it deep in the mud, but the spring brings it once more into activity.

With the advent of summer it is literally a giant refreshed, and nothing it can engulf is safe from its voracious jaws. It may forge its way up tributaries and canals, and even gain an entry to water-mains. So, slowly watching for the wherewithal to stay its insatiable appetite, it snatches mayfly from the surface and digs the crayfish from its burrow. Nothing living is deemed inedible by this ever-hungry eater, even its own brothers and sisters.

The entire form now makes for easy and swift progression. The long body is barrel-shaped and wonderfully supple. The slightly prehensile tail becomes compressed into a flattish paddle and may anchor the eel in swift currents leaving its head free to snap at and engulf such creatures as are within its reach. Forward movement is accomplished by sinuous movements of the body and fins, which are employed to a certain extent in walking, for as an eel grows, the more complete is its conquest, not only of the water, but the land. The dart-shaped head is perfectly formed for exploring the burrows of water rats and can force its way through mud or dense reed thickets. And where the head can go the body can follow. Moreover the gill chambers are capable of retaining a large quantity of moisture which the eel can draw upon for its life's blood in periods of drought.

Thus, well equipped for the battle of life, the eel steadily forages onwards So long as feeding is good it stays more or less in one place. The food supply exhausted, the onward march begins again. The stay in fresh waters may extend for ten years and possibly more. In a sudden drought it will lie in the mud or on some shelving bank till the rain swells the stream. Under cover of night it may progress overland through the dew-drenched grass, possibly eating as it goes, and only such behaviour explains the presence of eels in the Swiss lakes three thousand feet above sea level.

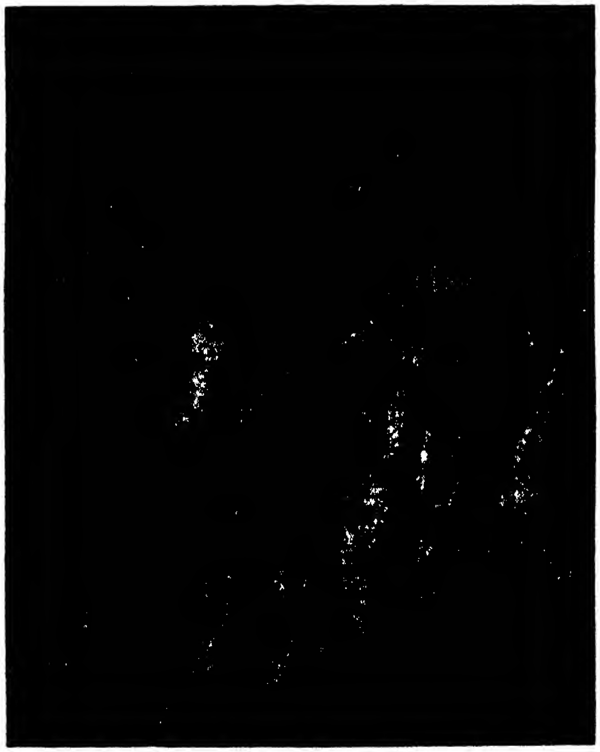
The female of the species is more deadly than the male, for the father eel seldom exceeds three feet in length, whilst the mother may reach nearly double that size and a weight of 25 pounds. The female develops a protruding jaw, an index to her pugnacity and voracity. The sexes live apart so far as mating is concerned until they meet again, as we shall see later, at their common birthplace in the far western Atlantic. Doubtless many a female eel engulfs a male and occasionally vice versa in European waters. It depends of course upon the size of the fish as to which engulfs which.

A large eel has been known to migrate from stream to pond and there drag down to destruction moorhen chicks and ducklings as soon as they were hatched Even the constricting powers of a large eel are not to be despised. Authentic cases are recorded of monster specimens that have been speared by herons and so involved their slimy coils with the avian necks that fish and bird died together. In all probability the birds died first, as the eel's vitality is amazing.

The fish is probably quite a stranger to pain as we understand the term, for a large eel caught not long ago in Lancashire was found to have three hooks embedded in its interior and they had evidently been there for many months buried deep in the intestinal fat. Yet the fish rose eagerly to a worm which proved its undoing. Even after being skinned and cut in pieces reflex action may cause the dismembered fragments to seem unpleasantly alive.

A FISH of such active habits in all situations would be seriously hampered by a covering of stiff unyielding scales. The eel's scales are minute and embedded in the skin, and a plentiful supply of very active slime glands accounts for the proverbial slipperiness. Being unusually sensitive to atmospheric pressure the fish is in many parts regarded as weatherwise. A thunderstorm, for instance, invariably arouses the creature, however great its previous lethargy. This may be explained by the fact that a thunderstorm always means the washing of much bankside food, worms, insects, and so on, into the stream, besides a dramatic disturbance of the stream bed. Ancient chronicles told how the old-time fishermen took advantage of this weakness on the eel's part and in the Fen districts actually beat drums on sultry nights to make the eels 'run.' The vibration near shallow waters lured the fish from their snug hiding places.

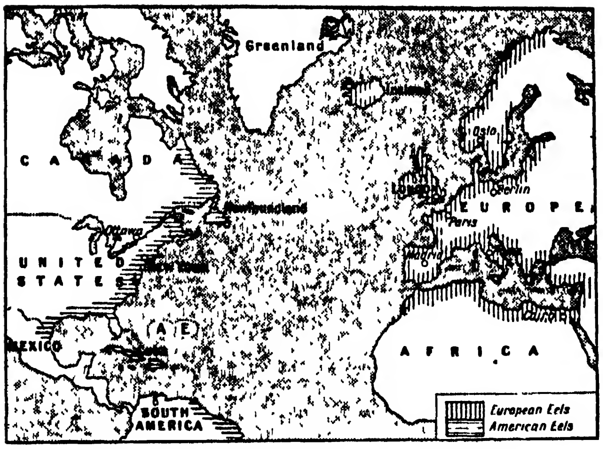
Eels are most active and adventurous after dark. In an aquarium they may be found in the morning several tanks away from where they went to bed. A specimen kept in the Regent's Park under-water zoo left its tank night after night to seek that inhabited by some sea anemones a considerable distance away. Every morning it was replaced in its own aquarium, but as soon as it was dark it wandered forth to seek the home of its choice. Eventually the zoo officials gave in and the obstinate



J. J. Ward

UNFISHLIKE SKIN OF THE EEL

A fish of such lithe activity as the eel would be greatly handicapped by a covering of stiff scales like those of ordinary fish. It has, therefore, only very minute scales embedded in its skin, a portion of which is shown in this micro-photograph



THE EELS' MID-ATLANTIC NURSERY

All the eels found in the rivers of Europe and America have been born far off in the dark depths of the Atlantic. Their breeding area is marked here with two small overlapping ovals, and the eels then travel east and west to the areas marked on the coasts, whence they pass up the estuaries in vast numbers and into the smaller rivers.

creature was left undisturbed to enjoy the company of the anemones, which it found such an attraction.

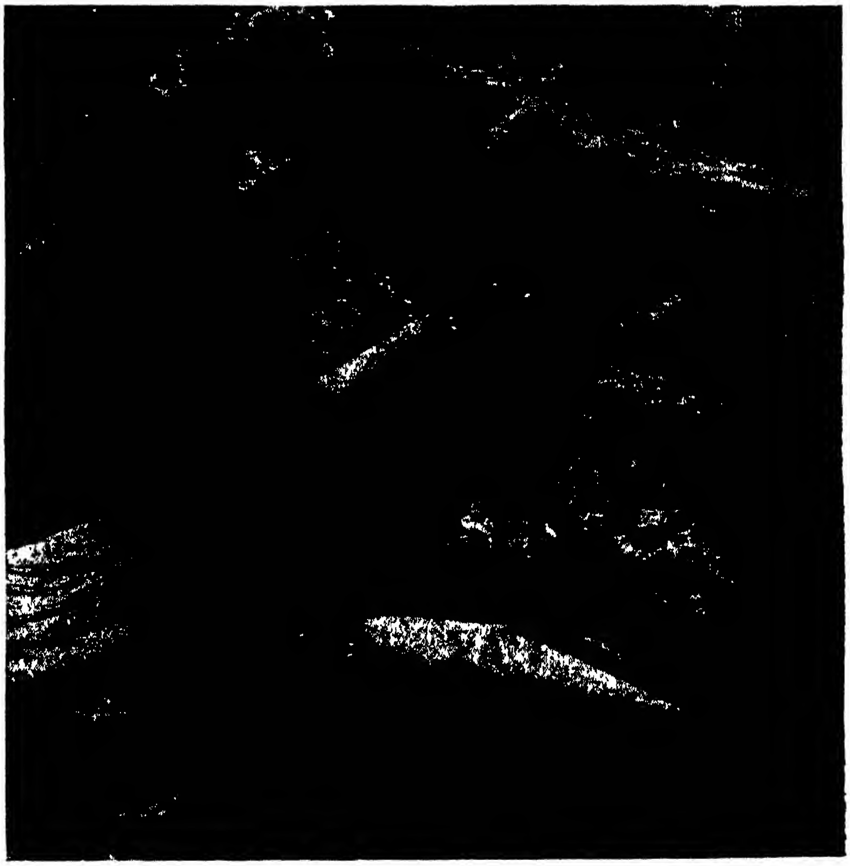
Sex becomes assertive when the eel is anything from seven to ten years old. Exact figures are impossible, this being among the minor eel questions still unsolved. Once, however, that the eel hears the call, it turns about and makes for the sea. The eel, having headed eastward, runs an even harder gauntlet than that which it hazarded when travelling from the Bermudas to, let us say, the Grand Junction Canal. Now it is fat and full grown and fair game to every man who is skilled to catch it. All manner of nets are placed in ranks across its path, and in Denmark alone the eel catch is worth annually over £100,000.

These eels, like all mature eels, have exchanged their olive brown clothing for a bright silver livery and are known as silver eels. In the Baltic at least they hug the coast for many miles and it has been found possible to mark specimens and note the rate of progress. One eel travelled at the average rate of just under ten miles per day for thirty days in succession. Other cases show such rates of travel as 230 miles in 29 days and 750 miles in 93 days. An eel marked and liberated in Finland in August was captured the following November off Jutland. In the Mediterranean region the eel is trapped in exaggerated lobster pots, huge cages three feet in length laid at intervals of twenty yards, each cage strung on a common rope.

It is sufficient tribute to the eel's fecundity that despite all the obstacles from the spawning to the fattening grounds and back again there is no marked shortage in the eel supply. In spite of the creature's increase in bulk the adult must find the homeward journey a very difficult one, as sharks, skates, and other sea beasts that may have easily overlooked the eel in its baby clothes now realise its existence and are bent on its extermination.

The common eel, like the rat and the sparrow, is one of those animals that has made its way in the world by virtue of its marvellous powers of adaptability, the true keynote of success in Nature. The common eel ranges from the Bermudas to the Swiss Alps, while all other species of eels and congers other than the common European and American species are, as at present known, confined to the sea.

There are many unfulfilled gaps in the life story of other members of the eel family and the scientific trawl and tow net continually bring to light fresh species of those curious transparent leptocephali.



A GOLIATH OF THE EEL FAMILY: THE GREEN MORAY

The common eel of European waters is not very big, but it has relations in the tropical seas that grow into giants ten or eleven feet long. The two eels shown in this photograph are goliaths of this kind. They are known as green morays and are found in the Atlantic and Pacific. They have been known to attack men. Fishermen catch them for food purposes.

F. W. Champion

AN AUTO-PORTRAIT OF THE KING OF THE INDIAN JUNGLE TAKEN AT NIGHT BY FLASHLIGHT AS HE TROD UPON A WIRE

This magnificent photograph of a tiger taken in the foot-hill jungle of the Himalayas, shows the animal at a distance of only thirteen feet from the camera. It is the finest picture of a tiger in its native lair ever taken, and great preparations and enormous patience were needed to get it. The photographer, Mr. F. W. Champion, having first of all discovered the track which the tiger regularly used, arranged the camera and flashlight apparatus to face this path and then set a trip-wire in such a way that if the tiger passed he would probably catch his foot in it, so setting off the light and releasing the camera-shutter For two nights nothing happened, but on the third night the tiger came and took this splendid portrait of himself.

Chapter VI

When Night Falls on the Jungle

A Chapter of Personal Adventure

By The Rt. Hon. Lord Lugard, G.C.M.G.

Formerly Governor-General of Nigeria; Author of "Our East African Empire"

MAN is undisputed lord of forest and plain in the hours of daylight. Elephant and buffalo, lion and tiger that fear no other living creature, will move away when his scent is borne towards them on the breeze, though they may challenge him if he comes unexpectedly upon them. The "rogue" and the "man-eater" alone have for one reason or another cast off the natural and instinctive dread of man. But when night falls man's supremacy is in abeyance, and he feels it. If he must perforce sleep in the open, he protects himself by a blazing camp-fire. If he ventures into the jungle he takes refuge in a tree. It is "night, wherein all the beasts of the forest do creep forth. The young lions roar after their prey . . . The sun ariseth . . . Man goeth forth unto his work and to his labour until the evening."

No one, I think, who has traversed the jungle by night, but has experienced that curious feeling of powerlessness—the consciousness that every hostile beast has quicker hearing, and scent, and better sight in the dark than he has His heavy foot is incapable of their noiseless tread, his weapons are discounted against their sudden onset in the darkness.

THE sportsman who has planned to spend a night watching some jungle pool has, however, generally settled himself comfortably before sunset that he may not miss the earlier visitors. The dead silence which falls on the jungle when the sounds which by day reach the ear without creating any distinct impression—the twitter of birds, the occasional scream of the fish eagle, the hum of insects—wholly cease, and all is still save the dancing fire-flies, and the noiseless passage of a night-jar, or a bat, or some night moth, is a silence like no other.

It was over forty years ago that as a youngster I was fired with ambition to achieve the distinction of killing a tiger—the Mansur man-eater in the Central Provinces of India, which had been responsible for the deaths of a great number of natives, and had baffled the efforts of a number of sportsmen. There was a big reward on his head and a big reputation to be won! Did ever a British subaltern exist who in such circumstances would not risk his skin to the uttermost? Had not the noted Padre shikari, brother to my old friend Sir James Willcocks, who had bagged the equally noted Higginghat man-eater, devised a plan and been covered with ridicule—and straw—in its failure?

It was in this wise: The Mansur man-eater was known to lie beside the road along which the laden country carts brought their produce by night to the neighbouring city. The tinkling bells of the oxen warned him of the approach of a ghari, and he had sprung on the sleeping driver and carried him off. So the Padre filled a ghari with straw and sat in it, putting a dummy man on the driver's seat The tiger got the dummy all right, but his impact upset the empty cart, and the Padre was buried beneath his own straw!

So I thought I would take no chances, if that is the right way of putting it, and I spent day after day following with my trackers the actual spoor of the tiger, and sitting at night in a machan over the water where he was due to drink. A machan, I must explain, consists of a few sticks lashed crossways to the boughs of a tree to form a seat, and there is sure to be one, made by natives to shoot pea-fowl over any permanent pool in the jungle.

It is a thrilling experience to watch breathlessly, as the sun goes down, and the moon begins to throw a fitful and weird light between the forest trees, when at any moment you may hope to see the great head of the tiger emerge noiselessly from the jungle.

On two occasions I had rather comical little adventures. The first was when a sudden storm with thunder and lightning and a deluge of rain came on. The peasants who make these machans are careful to put them high in the tree, well out of the way of danger, and consequently I was rocked about and my rifle slipped from my hands and fell. It banged against the tree trunk lower down but fortunately did not go off, and with some misgivings I made up my mind to go after it.

IT was pitch dark, and as I was drenched to the skin I thought it best to shed my clothes first I retrieved the rifle and regained my seat, but as the man-eater might for all I knew be looking on I did not spend more time about it than I could help. Had he come I think he could hardly have helped laughing—before he proceeded to business—at the ridiculous picture of a naked white man groping about for his rifle. I always had a small basket with a cold fowl and a piece of bread, and it was a relief when daylight broke to put on my partially dried clothes and light a pipe after breakfast

My second absurd adventure was on a later occasion, when after the same man-eater in a different part of the jungle. I had been on his fresh tracks all day. We had come to the conclusion that he had not drunk any water, and my native shikaris were convinced that he would unquestionably drink at a particular pool, the only one in the vicinity.

When we got there we found a lean and scraggy bullock which someone had tied up as a bait—not knowing that it was the man-eater, (who did not care

Major Radclyffe Dugmore

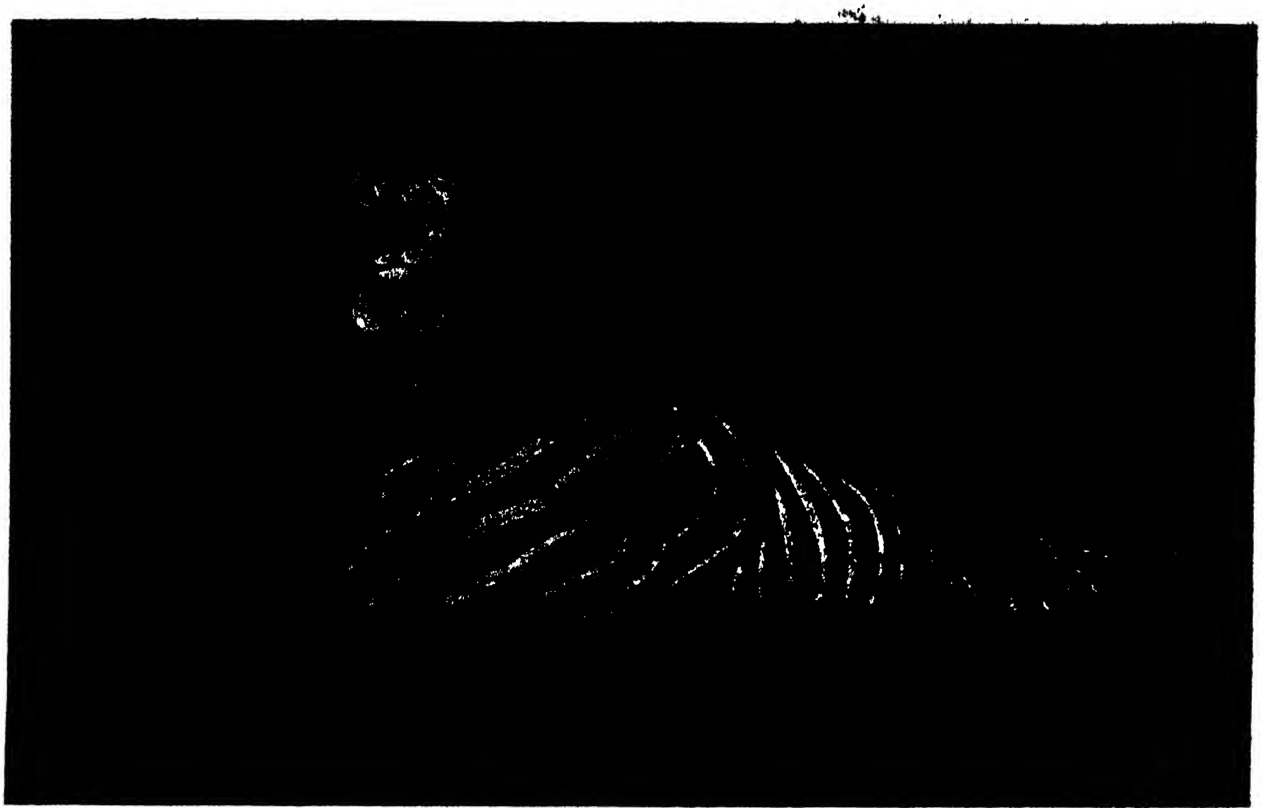
A GROUP OF HARTEBEESTS GO DOWN TO THE WATER-HOLE AT MIDNIGHT AND DRINK IN COMPANY

Despite the apparent stillness that comes over the jungle when darkness falls, there is nevertheless much movement among the animals by night They are continually travelling to and fro between their sleeping haunts and the water-holes where they drink Yet only the keenest human ear can detect signs of movement One moment there may be no animal at the water and a minute or two later a whole herd may be drinking The upper picture shows a group of hartebeests arriving at the water-hole, and in the lower photograph they are actually drinking

From the great adventure film "Simba" by Mr. and Mrs. Martin Johnson

BUFFALO AND RHINOCEROS REVEALED BY THE CAMERA IN THE DEAD OF NIGHT

The jungle by night is full of risks and uncertainties for the lonely explorer, and even if he hears a beast approaching his hidden camera he can never be sure of the picture which the developed film or plate will reveal. Here, however, are two pictures which the photographer regarded as adequate rewards for his solitary vigil. The rhinoceros in the lower photograph continued to stand still, quite unconcerned at the sudden glare. The upper picture shows a buffalo drinking. This animal, the most vicious of jungle beasts, is far more dangerous than the lion or tiger.



From the film "Simba"

YOUNG LIONESS FEEDING IN THE HOURS OF DEEPEST DARKNESS

Though human beings generally sleep at night and work and eat in the day, in the jungle it is different, for there most of the animals, especially the beasts of prey, sleep by day and come forth at night to seek their food. In this picture, one of the finest and clearest night photographs of jungle life ever taken, we see a lioness standing by a zebra which she has slain. She seems quite unalarmed by the flashlight, possibly because vivid lightning is so frequent in tropical lands that a sudden glare seems a perfectly natural happening. A moment later and she had begun her meal.

for ox-flesh), that was about. But alas, there was no tree anywhere near. The only apology for a tree was a sort of pollard, the stump of which was too close to the ground to be of any use. So we fell on the expedient of borrowing from the nearest village a charpoy—a native bedstead—and thought that if this were dumped on the top of the small branches of the pollard, and lashed to the largest of them, it would support my weight.

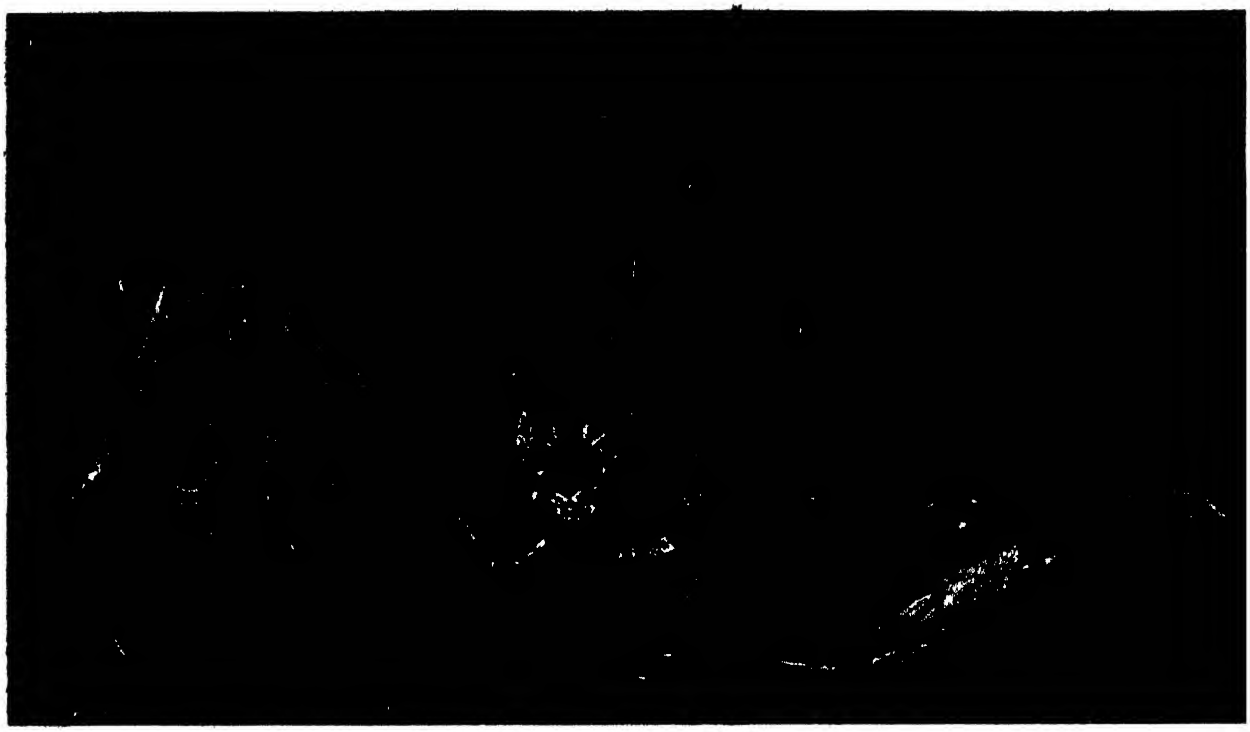
I sat cautiously on it, my food-basket at my feet and my rifle between my knees, hardly breathing with excitement as the hour arrived at which my tiger should make his appearance. Suddenly the sleepy old ox made a rush to one side, and the dry jowari stalks, left as fodder, made quite a crashing noise.

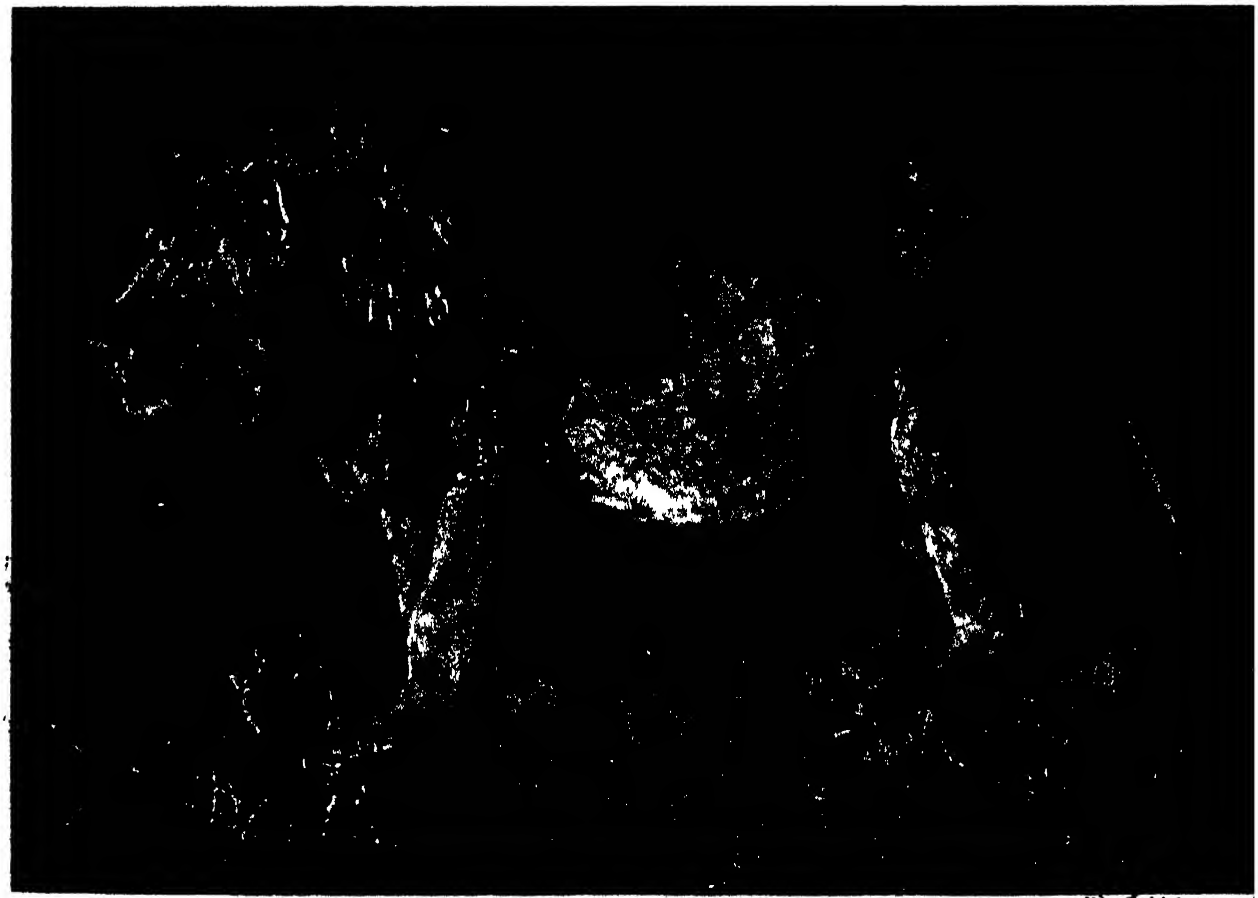
It could be nothing but the tiger—at last! I leaned very cautiously and breathlessly a little to one side to get a better view, when without any warning whatever the main bough gave way, and the charpoy, myself, and the cold fowl descended with a crash upon the bullock and jowari! The heavy rifle barrel struck me on the forehead when I landed on my back, and dazed me for a moment, but the position was so ludicrous one could not take it seriously. Whether the tiger had come or not I shall never know. If he had, the sight of a charpoy, a man, and a dead fowl descending from the sky must have scared him as much as it did me and the ox.

I got one of the man-eaters eventually—for there turned out to be two—a fine tigress, but not by sitting up at night. The Government reward paid for the rifle with which I shot her, and her skin with the little double-barrel ·450, are here in my study where I am engaged on subjects so different from those which I have been tempted to recall.

A few years later I spent a night in the jungle in Nyasaland. I was travelling up the lake in a small launch, and we had moored for the night. I had landed and shot an eland. We took the meat we required, and as I was told that the place was noted for the number of lions, I decided to spend the night in the tree nearest to the carcase. We made a strong machan, and an African—a magnificent specimen of a man—sat beside me.

THE surroundings were different from the Indian jungle. Instead of the leafless teak trees, there was verdant forest. Instead of the melancholy sunset call of the pea-fowl, and the distant belling of a sambhur, there was the hardly audible sound of a distant lion. But there was the same indescribable feeling of intense isolation, of being in a strange world peopled by aggressive carnivora who had got all the odds on their side. And there was a difference from the dry Indian jungle of which I had omitted to take count. Clouds of mosquitoes

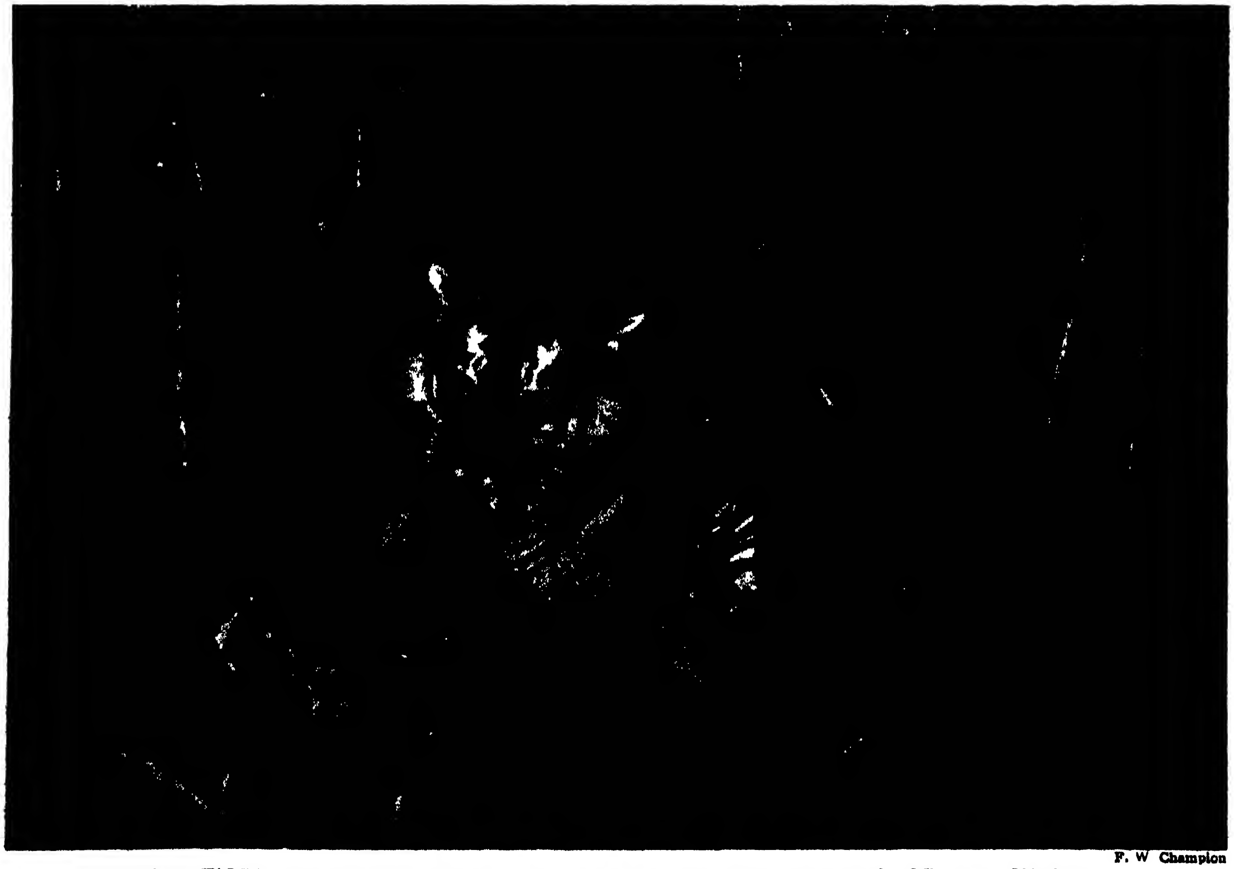




Major Radclyffe Dugmore

A LION AND HIS MATE PROWL THROUGH THE AFRICAN JUNGLE IN THE STILLNESS OF THE NIGHT

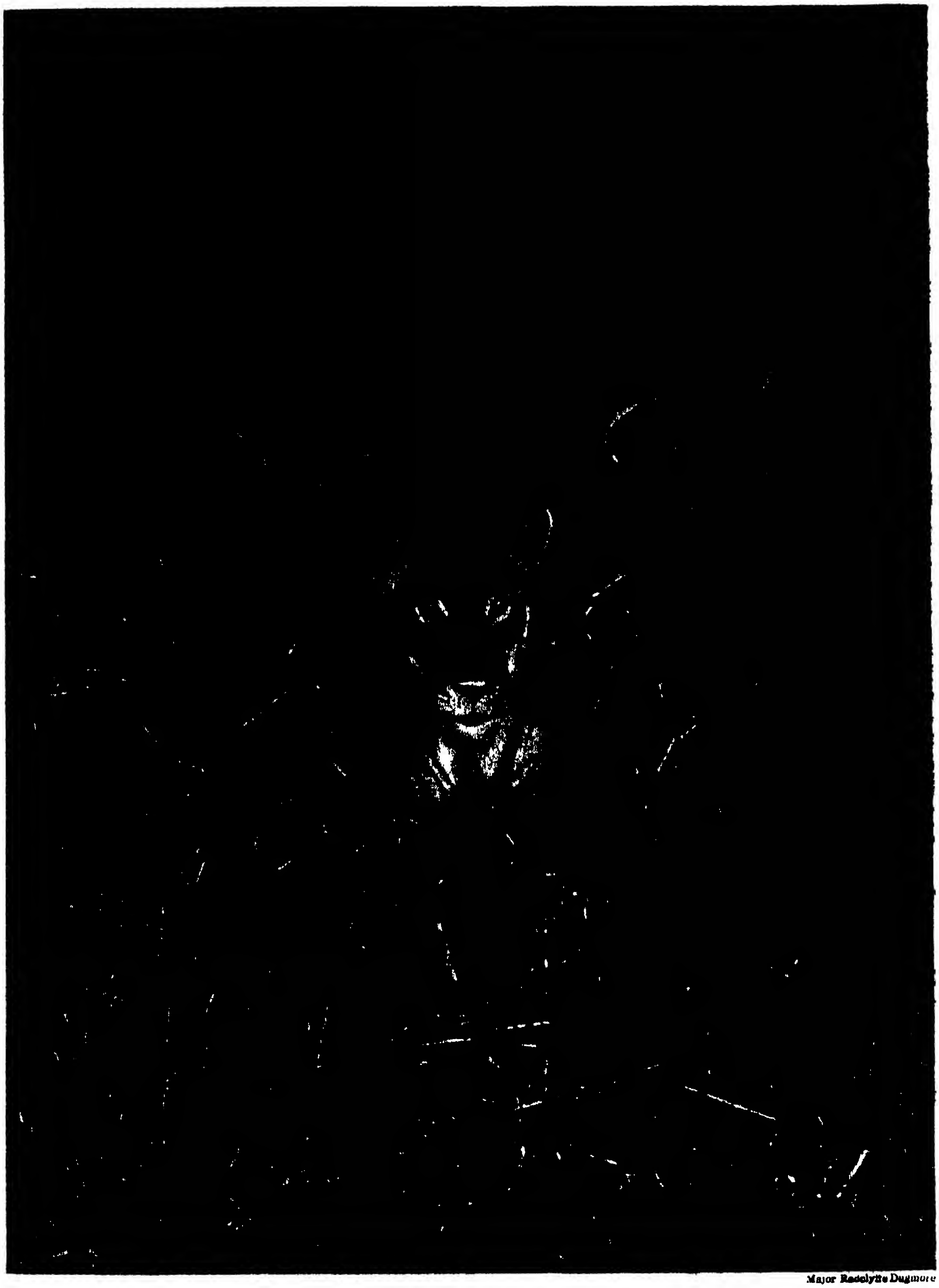
When darkness falls upon the jungle, and in tropical lands its descent is sudden, there comes a stillness that oppresses and appals. It is then, when every sight is blotted out, that man feels his utter helplessness. Only by an iron determination and a strong effort of will can the boldest explorer bring himself to spend a night away from his fellows, waiting long hours to bag a lion or a leopard with gun or camera. Fortunately, the camera is being used more than the gun nowadays. In the upper picture a lioness is coming back with stealthy tread to the animal she has killed the night before, and in the lower picture the lion is standing silently before the hidden camera, twelve yards away



F. W Champion

THE TIGER WALKS BY NIGHT AND FEASTS ON THE REMAINS OF HIS SUPPER

These pictures, automatically taken by flashlight in the Indian Jungle, show the tiger in two attitudes. In the upper one he is walking stealthily amid the tall grass of the jungle either in search of fresh prey or to visit the carcase of a previously slain animal Below he is seen quietly devouring the remains of such a supper As in the case of the photograph of a larger and older tiger in page 46 this picture was taken by the animal himself touching a wire that had been set beforehand to fire the flash and release the shutter of the camera



Major Radclyffe Dugmore

THE SUDDEN FIRING OF THE FLASHLIGHT REVEALS A LIONESS COMING TO HER PREY

In the eerie stillness of the night the explorer of the African jungle who waits to get a flashlight picture of a lion or lioness soon finds that his nerves are overwrought. The mystery of the darkness and the fancied footfall of approaching beasts inflame his imagination and people the jungle with ferocious animals all approaching his hiding-place. When this fine picture of a lioness creeping through the undergrowth was taken by Major Dugmore in the Kenya jungle, the animal came within a few yards of the camera, and, as the light flashed, looked straight at it.

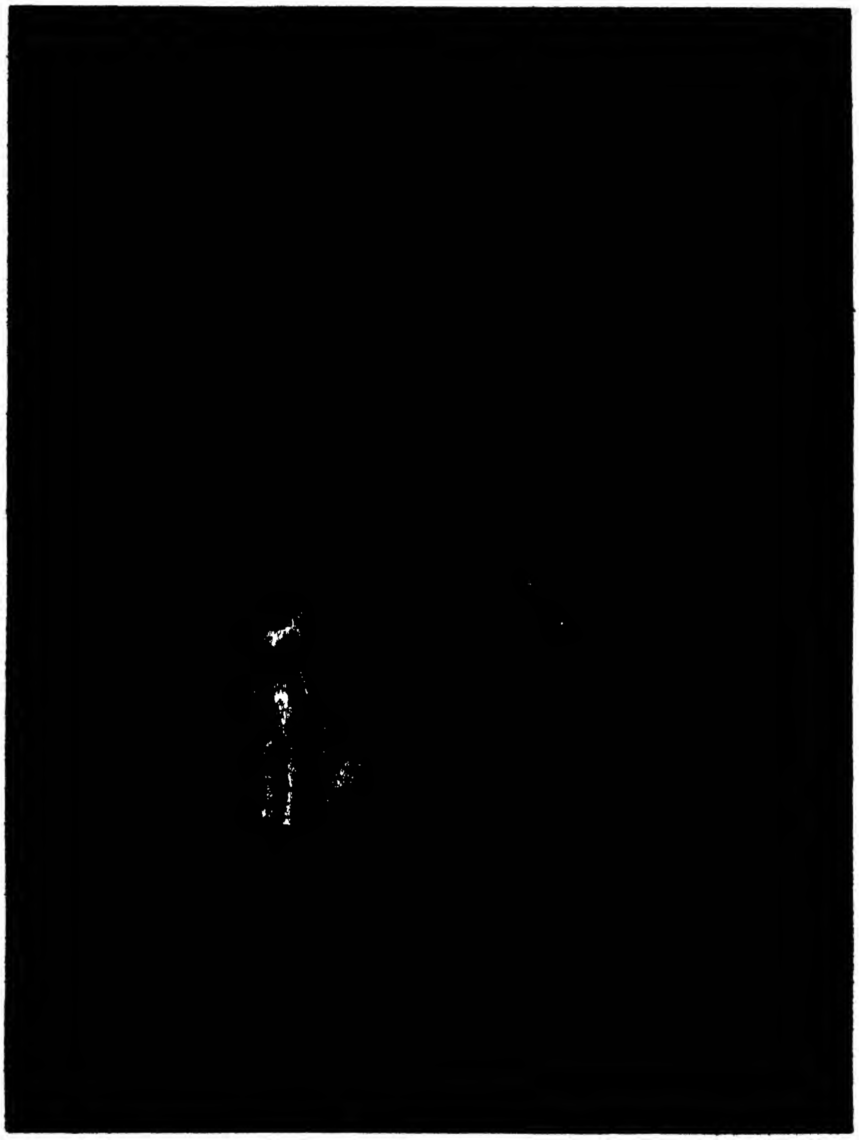
F. W. Champion

WHEN NIGHT COMES THE INDIAN LEOPARD SEEKS THE PREY HE HAS KILLED BY DAY AND DRAWN INTO THE JUNGLE

Contrary to popular supposition the leopard is a far bolder and more courageous animal than the tiger, and he shows little fear of man. To obtain a photograph of him in his native haunts by night involves an enormous risk, and requires a display of daring on the part of the photographer exceeding perhaps even that required for the taking of a lion picture in the African jungle. For the leopard can climb trees with ease and uses a tree as a coign of vantage from which to watch for his prey. At any moment, therefore, the photographer, waiting patiently for this picture in the dark, might have been pounced upon by the stealthy leopard and destroyed without warning or any possible chance of escape.

buzzed around, and there are few things better calculated to put an end to sentimental reverie! Before I had well appreciated the fact my face and neck and arms were smarting and itching desperately. The only cover I had was a waterproof sheet, and in the sweltering damp tropical heat it was not pleasant to smother one's face and neck and arms in such an air-tight covering. We were too far from our boat to make it possible to return, so my African and I spent the night in misery.

There was hardly a half-moon, and we could barely distinguish ghostlike forms around the dead eland, and, of course, it was impossible in the shadow of the tree to see even the barrel, to say nothing of the sights, of one's rifle. Modern aids to night shooting were not then in vogue. A rather ingenious idea occurred to me. I captured one of the fire-flies which danced around us, and with some sticky gum from the tree I stuck it on its back on my fore-sight, so that its luminous tail flickered constantly in the effort to get free. But it was impossible to make out what the forms round the carcase were. I suggested to my companion that we should get down and haul the carcase nearer. He failed I think to see anything very attractive in the idea, but Africans are brave fellows and will rarely refuse to follow a white man's lead.



A PROWLING LYNX FACES THE CAMERA

The Canadian lynx dwells in those deep forests of North America that correspond to the jungles of hotter lands, and when he moves about it is generally in a hurried gallop like that of the hare. He preys on the smaller mammals and on birds and has been known to devour pigs, lambs, and young fawns. Like most of the wild cats, he is bold, and here faces the flashlight without a flinch.

It was desperate hard work. An eland is a very large animal. An old bull will, I believe, stand nineteen hands at the shoulder. Grasping the horns our united strength could only move his head and shoulders a few inches at a time. Then we transferred our efforts to the other end of him, and by repeating the performance again and again we very slowly, with the perspiration pouring off us, gradually got the beast a little nearer. Meanwhile, my rifle lay handy in case of need and I kept a sharp look-out all round, for we had reason to think a lion had already visited the kill.

Shortly after we had got back to our tree the moon went down, and there was only dim starlight left. A stampede of the forms moving in the faint light—hyenas, jackals, or what not—told us a lion had approached, and presently I could clearly make out his shape as he moved off towards the high grass carrying some of the eland's entrails. I fired a wild shot, but it did not take effect. It seemed somehow an unnatural thing to hear the report of a rifle, and its echoes through the still night air, at such a time and place—as though one had let off a gun in a cathedral!

It got darker and darker, and there was no doubt now that one or more lions had returned. We could hear the crunching of the bones, but I did not fire again though I think I saw a lioness pass under the outlying branches of our tree. I was too tormented by the mosquitoes to care even about lions, and we were both heartily glad when the dawn broke and

enabled us to descend and find our way back to our boat. I had no time to try for better luck, for we were engaged at the time in fighting the Slave-raiders at Karonga's at the North End of the lake, a place which during the Great War was to be the scene of a notable exploit by our troops.

THOSE were days when we travelled with very few extras. It had not as yet become fashionable to photograph animals coming to drink, and to reproduce the scene on a cinema film in London. Shooting big game by sitting up over a kill, or over water, is at best a poor form of sport; for the game has not a fair chance, and I have never bagged anything in that way. It has its discomforts, no doubt, but with proper arrangements they can be minimised and the sportsman can sit in his tree and describe his impressions of the jungle by night with as much word-painting as he likes

But it is a different story if your acquaintance with the jungle by night arises from the fact that you have lost your way and are alone. That most terrifying of all experiences has happened to me more than once. The recollection of such a misadventure in Burmah is as vivid as a nightmare to me even now.

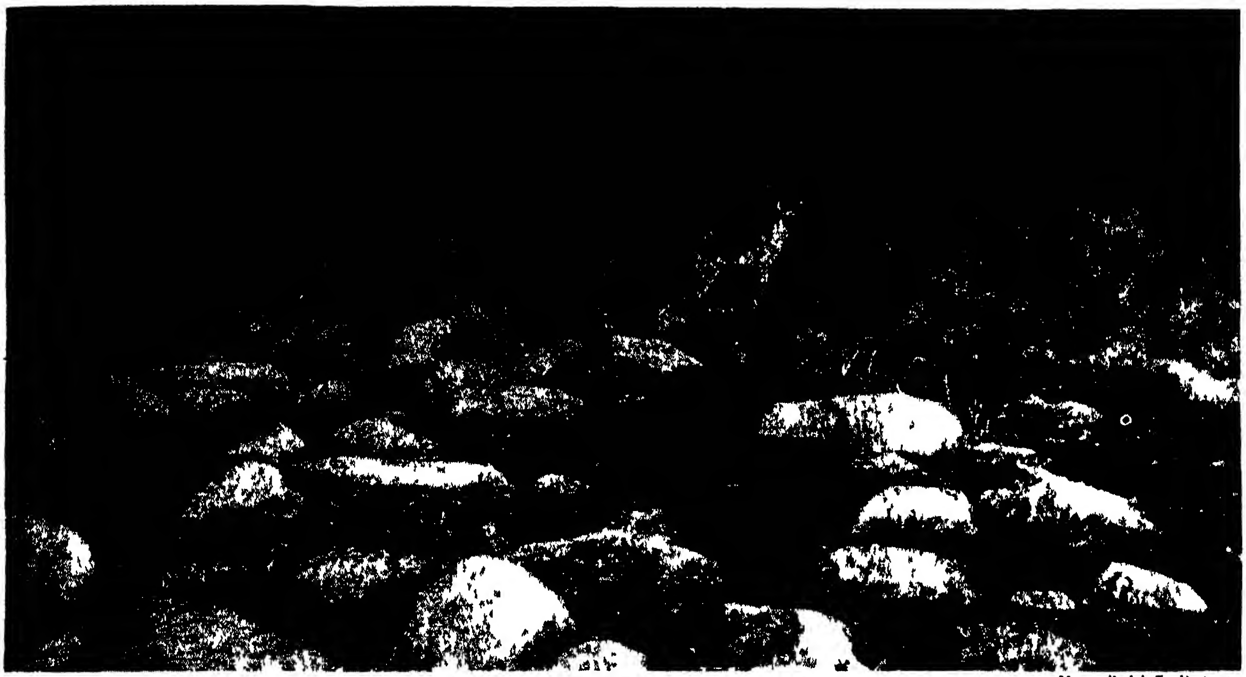
It was in the interminable bamboo forest which stretches from Kycnyat to Sagardoung, north of Mandalay. Nothing grows under the great bamboo clumps, so that the forest, unlike other jungles, is practically pathless, and as the fronds meet overhead you can see no landmarks and rarely even the sky. I found later that following cart-tracks which I thought were those of the British force to which I belonged, I had nearly blundered into the camp of our enemy the Shans, who were reputed to have an extremely unpleasant custom of torturing captives by driving bamboo splinters between their finger nails and fingers, and finally splitting them open and pegging the unfortunate captive down on a white-ants' nest.

The feeling of utter and complete helplessness in such circumstances is one which has no parallel except in the Arctic ice-fields or in a nightmare. Should you go forward or backward, or to right or left? Have you reached your objective or not yet reached it? Which is forward and which is backward? Your reasoning faculty cannot help you, and your best course is to sit down where you are till daylight—or rather twilight under the bamboos—with such philosophy as you can command. You will I imagine be more engaged in considering how empty you are inside, and remembering that there is nothing whatever to eat than in moralising over what the jungle looks like at night! It is curious how vivid memories such as these remain when many serious and important incidents of life have passed into oblivion.

Major Radclyffe Dugmore

CROCODILE RESTING ON THE BANK OF AN AFRICAN RIVER BY NIGHT

While the large carnivores hunt their food by night and the feebler folk go to water-holes to drink, the crocodile does neither, and if in the glare of a flashlight he is seen at all it is usually, as shown in this photograph, resting on a bank When he needs food he simply submerges his body and lies in wait for some unwary animal or human that may come down to drink or bathe Then, with a sudden snap, he seizes his prey and drags it under the water to drown There is no escape from the jaws of this powerful reptile.



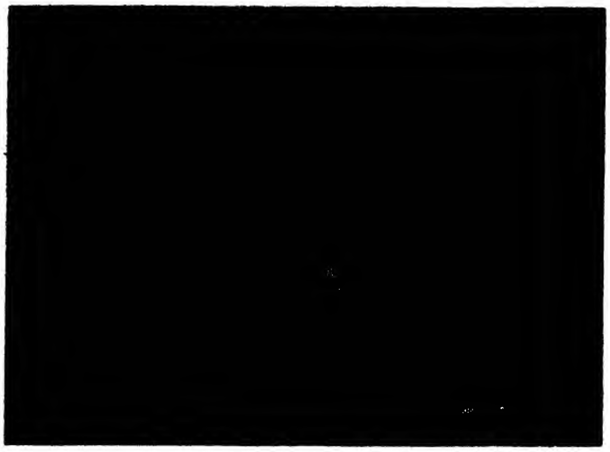
Maj r Rad lyffo Di gmole

From the film Simba

SPOTTED HYENA CAUGHT IN THE FLASHLIGHT AS HE STANDS BY A WATER-HOLE

The spotted hyena of Africa is essentially a creature of the night, and where a party of explorers is encamped in the darkness he will creep in silently among the tents and attack the tethered mules, ponies, cattle, or goats without warning He is much fiercer than his Indian relative and so powerful are his teeth that he can as easily crunch in his jaws the shinbone of an ox as a dog can crunch up the leg bone of a chicken He visits the water holes at night, partly to drink and partly in search of food and these photographs were taken during his nightly prowl

Ostrich



Adjutant Stork

Secretary Bird

Curassow

Boatbill

Neville Kingston

Spoonbill

BEAKS CUNNINGLY ADAPTED TO VARIOUS MODES OF LIFE

The boatbill's flat beak is well adapted to catch fish, while the spoonbill's with its broad flattened tip is used for sweeping from side to side in the mud and water for vegetable and animal food. The secretary bird, shown here in an angry mood, has a beak like an eagle's, but that of the curassow is short, stout, and often enlarged at the base. It is interesting to note that the ostrich's beak, flat, broad, and blunt, with nostrils in the middle, is the most primitive bill carried by any modern bird. The adjutant stork's enormous beak is thick and wedge-shaped

Chapter VII

Beaks of Infinite Variety and Uses

By Frank Finn

Author of "The World's Birds"

There is a well-known scientific saying that in the course of its development every animal climbs up its own genealogical tree; that is to say, that the young stages in its development show what its ancestors were like.

Judging from this, as every bird is hatched with a beak, but some of them, the common sparrow for instance, come into the world without a trace of feathers, one would infer that birds developed beaks before they had feathers. This, as they evolved from reptiles, would make them comparable to tortoises, which have horny jaws or beaks; in one of the sea-turtles, in fact, the beak is so like that of a bird that the reptile is known popularly as the hawk's bill turtle.

The above statement about creatures' genealogical gymnastics is, however, only generally true, and the case of the birds' beaks furnishes one of the exceptions to it; for the earliest bird-fossils show us creatures with quite normally developed feathers, but with jaws bearing teeth, which must have been more like the muzzle of a lizard than the beak of any bird we know.

Teeth were possessed by birds long after they had separated into very different forms. The first birds we find were evidently tree-livers, adapted for perching and with short rounded wings which were suitable for easy flights, from tree to tree or from glade to glade, a pattern of bird still very numerous in the tropics at the present day, as anyone may see who visits the Bird House at the Zoo. But the next fossils show us gigantic divers with little bits of wings, and strong-winged flyers with wings as powerful as those of our modern gulls—and all still had the reptilian teeth in their jaws, so that teeth must have been universally in fashion for ages.

In all modern birds the true teeth have so completely disappeared that no trace of them can be found even in the unhatched young; but false teeth have been developed in a good many birds, as in the merganser, a fish-eating duck. Such false teeth are mere projecting points on the horny edges of the jaws, and are quite unlike real ivory teeth such as mammals possess which are separate growths and are shed.

Neville Kingston

THE POWERFUL BEAK OF THE MACAW

Macaws are very showy birds but poor talkers, and their nasty habit of screaming almost incessantly makes them undesirable pets. They have a very large and powerful beak, and the upper jaw, owing to a peculiar joint, can be thrust straight out.

It is likely that the jaws of the earliest birds were covered with skin and had, as those of lizards now have, large scales at the tip and along the edges, and, though true teeth have so long disappeared, we have, perhaps, a trace of this covering in the beaks of some birds of the present day. Generally each jaw is covered with a continuous sheath of horn, like that which covers the claws; but in the duck family and the flamingoes the beak is only horny at the edges and at the extreme tip, where it forms what is called the nail, the rest being clothed with skin. It is upon this skin that are made the cuts on swans' beaks which form the swan-marks formerly so much in use, and still inflicted locally.

Then in many birds, especially birds of prey, though most of the beak is horn-cased, the part surrounding the nostrils is clothed in a skin called the cere, from the Latin word "cera," meaning wax, which the surface of this skin very much resembles in some cases.

Owls have the cere as well as day birds of prey, but in their case it is so buried in feathery whiskers that it is not generally noticed. Parrots also have the cere, and the crow tribe have feather-covered skin at the root of the beak, which in the rook becomes bare and exposed at about a year old as the result of an hereditary disposition to baldness, not through digging, as used to be supposed. In the snipes and woodcocks the end of the beak is soft-skinned and sensitive, so that they can feel worms when boring in mud.

In many birds, too, although the beak is completely sheathed in horn, the horny casing is in several separate pieces, evidently another reminiscence of ancient arrangements. This is the case with all the ancient loose-plumaged running birds or ratites, from the ostrich to the kiwi or apteryx, and also in many of the flying birds, such as the frigate-bird and pelican and their kin, and the petrels and albatrosses.

The last are the only birds which have real noses, their nostrils being

prolonged into tubes; in the albatross the nose is split, for there are two tubes, separated by the bridge of the beak. False unpierced noses have been developed in many birds, however, such as the knob which adds dignity to the swan's beak, and the combs of the condor and the Indian comb-duck, while the turkey sports an elastic nose which lengthens or shortens according to the wearer's frame of mind.

Birds' nostrils have generally been shifted back towards the forehead, where they are out of the way; or, rather, the beak has tended to develop in front of them. But many birds still have them about the middle, such as geese, gulls, and the ostrich tribe, among which the kiwi goes farther, and has them at the tip, protected by a flange. Nostrils being usually at the end of a nose, the forward position is no doubt the ancient one, though they need not have been, and probably were not, at the actual end, since some of the monitor lizards have them some way back on the snout.

Taking it all round, the beak of the ostrich, flat, broad and blunt, with nostrils in the middle, a covering of horn in separate plates, and a deep mouth reaching back under the eye, is the most primitive and muzzle-like beak carried by any modern bird.

The deep mouth is certainly a reptilian point, and in few birds except the ratites and the pelican tribe is it found; but the morepork shows it very well, and with its broad, blunt, very short beak, looks particularly reptilian; indeed, it belongs to a family known as frog-mouths.

Generally the corner of the bird's mouth reaches about half-way to the eye, and in some birds the contraction of the mouth has gone so far that it does not reach further back than the forehead; this is the case with parrots and with the duck tribe, and with all the group of mud-probing birds, such as the snipe, dunlin, godwit, whimbrel, and curlew. This last family shows an extraordinary variety of beak; it may be quite short, as in plovers, and turned the opposite way to the curlew's, as in the avocet; but the narrow mouth makes the faces of the whole clan remarkably alike and very silly-looking.

In other birds one pattern of beak has to serve for a whole group; for instance, the beaks of the game-birds are very little different, whether they feed on berries in the tops of tropical trees, like the American guans, on the ground on all sorts of things, like the fowl, pheasant, and turkey, or on the buds of stunted herbage under the snow, like the Arctic grouse.

Their natural enemies, the birds of prey, also show a very uniform type of bill, with a curving hook at the end, though here there is more variety; the great bill of the eared vulture, which is one of the master-vultures, is stronger than the golden eagle's, and contrasts strikingly with the weak bills of the smallest vultures, which are not unlike those of the large crowned pigeons.

Pigeons, as a family, have remarkably weak bills, though the fruit-eating kinds have stronger beaks than the seed-eaters, the beak in one of these being quite as strong for the bird's size as that of the condor. Fruit often takes a strong pull to detach it, and in any case fruit-eating creatures often have to make shift with buds, for even in the tropics, where perpetual summer reigns, fruit is not always on hand just when and where feathered or furred fruitarians may happen to want it.

So, what with the resemblance between some pigeons' bills and vultures', and other pigeons' bills and those of the worm-eating plovers, to say nothing of the likeness between parrots' bills and those of birds of prey, we often find animal-feeding birds and vegetable feeders also, managing to get along with very much the same type of bill.

The outstanding peculiarity of the parrot's bill is the attachment of the upper jaw by a joint; owing to this arrangement the parrot can poke its upper jaw straight out, and a macaw will do this when trying to smile, producing a weirdly comical expression, enhanced by the fact that the corners of the bird's mouth are soft and elastic like ours.

The somewhat human expression of the parrot's face, and its thick tongue and short, hollow beak, by the way, have nothing to do with the bird's power of imitating our speech, for the vocal organ of birds is situated nowhere near the mouth, but at the base of the neck, and birds with tongues and beaks quite different from those of parrots will learn to speak, as everyone knows.

Among such are the crow tribe, which have what may be called the standard or ordinary beak among birds, neither particularly long, short, thick, nor thin as a rule, though we get length and thinness in the chough's beak, and a decided increase in thickness in that of the thick-billed raven of Africa. Crows put their handy beaks to all sorts of uses, being eminently birds of all trades, and the beaks of thrushes, starlings, and a vast number of other birds differ but little from the crow type of beak, except in being smaller.

The birds known as barbets have beaks very much like those of crows, and, though little known to the public, they are particularly interesting in forming a link between the woodpeckers and the toucans. Barbets peck out their nesting-holes with their crow-like beaks, but woodpeckers are always carpentering, since their chief food consists of grubs which they dig out of rotten wood, and so the slight curve of the barbet's bill is in them straightened out; the end of the bill is squared, and it becomes a very powerful chisel.

The woodpecker has been pitied for its life of toil, but it is as happy with its chisel-bill as a boy with a new pocket-knife, and quite recently a woodpecker in the Brent Valley bird sanctuary got itself into disgrace by its enthusiastic cutting operations on the nesting-boxes provided for other birds. On the other side, the barbets have evolved into the toucans, which are Roman-nosed to a degree, and have the biggest bills for their size of any birds. This, however, applies only to the larger species; in the smaller

Ground Hornbill

Toucan

Black Hornbill

Thick-Billed Raven

Common Raven

Whale-Headed Stork

Neville Kingston

THE GIANT BILLS CARRIED BY BIRDS OF DIFFERENT SPECIES

The raven, once common in Britain but now rare, has a stout strong bill, arched towards the point, and sharp at the edges, while its relation the thick-billed raven has the tips of its beak hardened somewhat in the way that a gold fountain pen-nib is hardened by being iridium-tipped. Very different is the beak of the whale-headed or shoe-billed stork, which is broad, concave in profile, with a strong ridge, and the tip extended into a bold hook. The bills of toucans and hornbills are so huge as to be like caricatures. They are, however, not as heavy as they look.

toucans the bills are not quite so exaggerated, and in size of bill there is little to choose between the smallest toucan and the largest barbet, the chain of links being very complete.

The big beak of the toucan is not such a practical affair as the smaller ones of its middle-class and industrial relatives, and toucans find their nesting-holes instead of digging them, though no doubt the out-sized bill comes in handy in defending the entrance, as well as in reaching out to pick the fruit on which toucans mainly feed.

The only other birds in which the bill is as grotesquely exaggerated are the hornbills, which represent the toucans in the Old World, and generally have very similar habits, so that here we have a case of evolutionary history repeating itself. History, however, never repeats itself exactly, and the hornbills have seldom developed the brilliant colours which so often adorn toucans' bills, but instead, usually show a curious top-storey arrangement, varying much in form.

W. S. Berridge

A FALSE BEAK WORN FOR COURTING

One of the most remarkable of all the beaks is that of the puffin, which grows a brilliant or temporary, beak at the breeding season, as seen in this photograph. In course of time the false beak flakes off, and when winter comes the puffin has a plain black bill

Moreover, the opening chapter of the history of hornbills is lost to us, for though the hornbills are undoubtedly related to the hoopoes, and more distantly to the kingfishers, and though the smaller hornbills have proportionately slighter bills than the larger ones, and usually lack the top-storey, the family does not grade off into any other as the toucans do into the barbets.

BOTH toucans and hornbills have the interior bony core of the bill very spongy or cellular in structure, which lightens it greatly; but nevertheless it is decidedly heavy, and it is remarkable that its weight does not inconvenience the birds, which are as active as if their bills were of the ordinary size.

Apart from the toucans and hornbills, most of the birds with eccentric or exaggerated beaks are waders or swimmers, and some of them have beaks so specialised that they are practically tied down to one particular way of living. One very well-known instance of this is afforded by the pelicans, which use their long pouched bills as a fishing-net; the branches of the lower jaw are united only at the tip, and will expand freely, forming a skin-floored scoop which shovels up water and fish together, the water spilling over the sides as the bill contracts again.

The opposite formation is seen in the even more specialised scissor-bills, which belong to the tern group, members of the gull family which usually have the ordinary or crow type of beak. In the scissor-bill the branches of the lower jaw are joined for so long a distance up that when detached from the skull it looks like a pitchfork, and when in position it projects as a thin, vertical blade far in front of the upper jaw. Thus food cannot be picked up in the ordinary way, and the bird feeds by skimming over the water with the end of the lower jaw immersed, and snapping down the upper one on any prey that is touched.

The spoonbill is so closely related to the ibis, which has a beak almost exactly like the curlew's, and uses it in much the same way for picking and probing, that a spoonbill-ibis hybrid was once bred in the Berlin Zoo; yet its beak is remarkably different, and is used in sweeping from side to side in the mud and water, securing both vegetable and animal food between the broad flattened tips.

The avocet, belonging to a quite different family of waders, the snipe and plover group, uses its thin, tapering and upturned beak in a very similar way, but at the surface of the water, its habit being to devour duck-weed as well as small animal life.

STORKS and herons have, as a rule, a very uniform type of bill of the spear pattern, but in the adjutant this is greatly exaggerated in thickness, this bird being largely a carrion-feeder, and needing a carver, while the shoe-bill, whose beak looks like the pelican's much shortened and broadened, is said also to use the hook of its bill in tearing carcases, though usually, at all events, it is a fisher.

The crossbill furnishes an example of a peculiar specialised bill among the small perching birds; except for its beak it would be a quite ordinary finch, and indeed looks very like one when it leaves the nest. But the bill soon develops the crossing hooks on the upper and lower jaws, which form an admirable pair of pliers for prising open the cones of fir and pine-trees, on the seeds of which the bird feeds; but it can be adjusted to pick up seeds in the ordinary way and to take insects, while a crossbill will also do much execution, parrot-fashion, on the woodwork of a cage, so that its deformed-looking beak is really a whole tool-box in itself.

Similar varied use of a specialised beak is seen in the common duck, the beak of which is furnished with rows of horny sifting-plates for straining small

Eared Vulture

Golden Eagle

Flamingo

Sacred Ibis

Sheathbill

Morepork

Neville Kingston

SOME STRIKING EXAMPLES OF THE CURIOUSLY VARIED FORMS OF BEAKS

The sheathbill, which feeds on other birds' eggs, has its beak sheathed at the base to prevent the liquid from penetrating the nostrils The morepork, or frogmouth, has a short, blunt beak, very reptilian in appearance. The flamingoes feed like ducks with the bill reversed, the upper jaw, which is very mobile, acting as the lower one. The ibis is closely related to the spoonbill, but its bill is very different, being adapted for picking and probing. Birds of prey always have powerful hooked beaks, and the eared vulture's is stronger than the golden eagle's

animal life, seeds, and so on, from mud and water, yet the duck, as everybody knows, easily picks up grain and browses on vegetables on land, besides hunting small prey of all sorts

In the shoveller-duck the sifting plates are so much developed that they can easily be seen from the outside, and look like whale-bone on a small scale, while the beak is broadened into a shoe-horn shape. Thus it is a most perfect sifter, and the shoveller is the most frugal of ducks, give him a puddle with a few gallons of dirty water, and he will contrive to dredge a dinner out of it. But he can still feed on land, which the flamingoes, rivalling him as water-strainers, can hardly do, for they feed like ducks with the bill reversed, the upper jaw, which is very narrow and movable, acting as the lower one. Here again, then, we have a beak which ties down its owner to a certain method of living, and flamingoes are only found where large expanses of calm, shallow water exist, where they can wade and dredge

Neville Kingston

THE PELICAN'S BILL WITH ITS WONDERFUL FISHING NET

Some birds, like the pelican, have beaks so specialised that they are tied down to one particular way of life This bird has a big pouch attached to the bill, which it uses as a fishing net, scooping up water and fish together and allowing the water to spill over the sides as the beak is closed The bird spreads the pouch over its chest to dry it, as in the upper picture.

It is curious that, though birds' beaks are so often specialised for food-getting, they are not so as nest-making tools. A bird will contrive to make almost any sort of nest with almost any sort of beak; the weaver-birds construct their wonderful plaited nests with beaks much like those of our ordinary finches; the kingfisher, with its long strong bill, and the sand-martin, with its tiny weak one, both dig out an underground home.

Neither are birds' beaks, at any rate as a rule, specialised as weapons. They are very handy in that capacity, it is true, and are generally so used in conflict both among birds themselves and with other enemies. But it is difficult to find a beak that is specialised as a weapon, though this may be the case with the toothed beaks of the male saw-billed humming-birds, humming-birds being excessively quarrelsome, and given to beak-clinching in a fight.

In many cases, however, the beak does seem to be specialised for ornament; the top-storey of the beak of the hornbills—which is sometimes different in the two sexes—the fleshy appendages of some birds we mentioned at the beginning, the horny "saddle" on the bill of the saddle-billed stork, and the bright colours on the bills of many birds, the toucans especially, may be thus accounted for, if it be ever proved that birds do select their mates for appearance.

The puffin goes the farthest of all in this direction, for it grows a gaily-coloured false beak in the breeding-season. this flakes off in time, and "Sea-Punch," as the Italians call him, and his Judy, go off to the open sea for the winter in plain black beaks.

Chapter VIII

How Animals Express Their Feelings

By Frances Pitt

Author of "The Animal Mind," "Waterside Creatures"

ANIMALS have keen emotions, as is soon apparent when you watch the expression of their feelings, though they vary much in the manner they display them, from the angry spit of an enraged cat to the weeping of a frightened seal. Hate, anger, love, fear, boredom, and anticipation of good things to come are all expressed each in its various ways by the different creatures.

Seals are among the few animals that share with us the distinction of finding an emotional outlet in weeping. I have seen a young grey seal—a pup of the great grey seal that comes ashore in the autumn, choosing some retired nook upon the wildest coasts as a nursery for its solitary baby—cry pitifully because I was between it and the sea, and it could not escape to join its mother, who was floating in the sea a little way off the rocks, her dark head showing just above the surface of the waves. Tears of fear and anger ran down the young seal's face, making rivulets through its velvety fur, until they melted my heart, and I stepped out of its way, to let it heave itself over the shining seaweed-covered rocks and away into the green water

No creatures display anger more effectively than the members of the cat tribe, from the stately tiger, the leopard, the lynx and caracal, down to our homely puss. In all of them anger is shown in more or less the same way, by spasmodic twitching of the tail in the long-tailed species, by flattened ears, ruffled fur, and explosive spits, varied with growls and menacing sounds. Only the other morning I was watching two cats, common household ones, purring happily side by side, when suddenly one cat stepped back, with ears flat, tail twitching, and spat open mouthed at her friend. What the cause of offence had been I cannot say, but next instant the two were fighting as only cats can, in a continuous storm of growls, hisses and furiously scratching claws

But for sheer temper one must turn to the wild cats. One of the worst is the Scottish wild cat, *Felis silvestris*, not only a distinct species from the domestic, but differing from it in temperament so much as to be quite untamable. Fear and hate gleam from its half-closed green eyes, and woe to the man or dog who attempts to interfere with the fury.

A cat's whiskers are a good indication of its feelings, whether that cat be a tiger, leopard, or something smaller, for when the owner's attention is fixed upon anything they bristle forward, only to relax as its interest wanes, and lie almost flat as it becomes sleepy or bored.

Boredom in the animal world is unmistakable, a wide-mouthed yawn being its sign among all creatures, from ourselves, through the apes, monkeys, dogs, wolves, and cats, down to the birds I have seen a weary falcon yawn repeatedly, likewise a bullfinch that was tired of sitting on her nest brooding her eggs, a horse waiting in the stable with nothing to do and many an animal in zoological gardens

THE GIRAFFE "REGISTERS" HOPE

A giraffe has this advantage over the other animals at the Zoo, that he need not always see the world through the bars. He can look over them as this one did when he heard his keeper coming perhaps with the next meal Hope is strongly expressed in the pricked ears and intent gaze

But there is one point about the yawn of boredom which should not be overlooked, and that is the bored animal does not lift its lips so as to exhibit its teeth as does the angry one. An enraged baboon, dog, or cat displays its whole dental outfit in a snarling grin. Note the photograph of two baboons shown in page 67, one rather bored and the wild cat in page 75 very annoyed —and the difference is obvious.

Some creatures, however, do not open their mouths or lift their lips even when really angry: such are the members of the weasel tribe, stoats, martins, polecats, otters, and badgers, likewise the skunks, which are contented to bristle up and give a warning hiss when

G. Reid

WHISKERS WHICH REVEAL INQUIRY

Watch a cat's whiskers to discover its feelings, whether that cat be the domestic sort or a tiger or a leopard. The intent expression is always marked by a slight bristling forward of the whiskers, and pricked ears and wide-open eyes help to emphasise this cat's expression of inquiry.

they are prepared to do battle. They do not ever indulge in superfluous snarling.

Different birds have peculiar ways of displaying anger and indignation. The angry secretary bird, for instance, is a good study in irate expression, while the owls in particular leave no doubt about their feelings, putting their feathers on end, drooping their wings, and glaring furiously at the offender. The eagle and long-eared owls, with their magnificent orange eyes, which seem to glare hate and rage, are particularly impressive when in a temper; but for weird antics commend me to an annoyed barn owl.

THE barn owl is the so-called white owl—it is pale buff in reality, but looks white when on the wing—which is widely distributed throughout the northern hemisphere. It varies a little in different parts of its range, but one barn owl is much like another, and all behave in the same way when really upset. An angry white owl half closes its eyes, droops its wings, stands as high as it can and moves its head round in a circle, at the same time making a most extraordinary snoring sound, sometimes interspersed with a little beak snapping. One may sometimes find the bird engaged in this display, which seems to express the combined emotions of fear and anger, and serves the purpose of bluffing an enemy into thinking the owl an awful and dangerous creature.

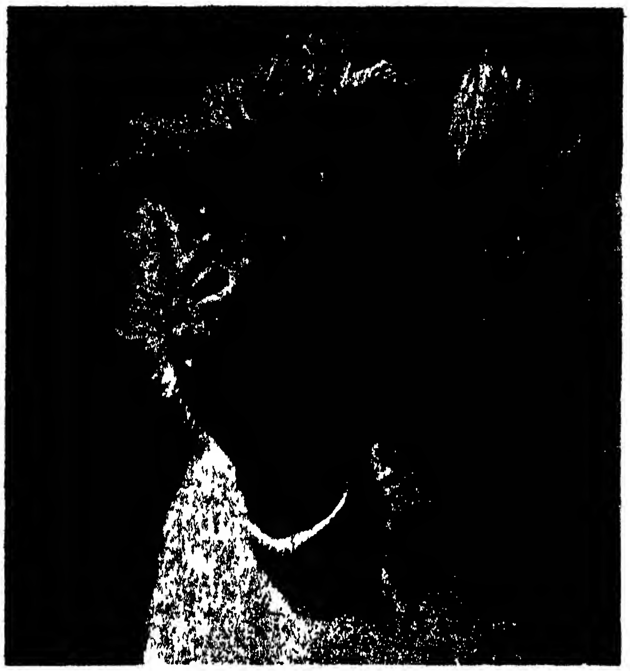
In most cases the displays of temper indulged in by birds and beasts have a useful object, namely that of intimidating a foe. There is no doubt that the snarling and growling of an angry dog, and the spitting of an enraged cat, are not only outlets for emotion, but tell the enemy these animals really are furious and should not be lightly attacked.

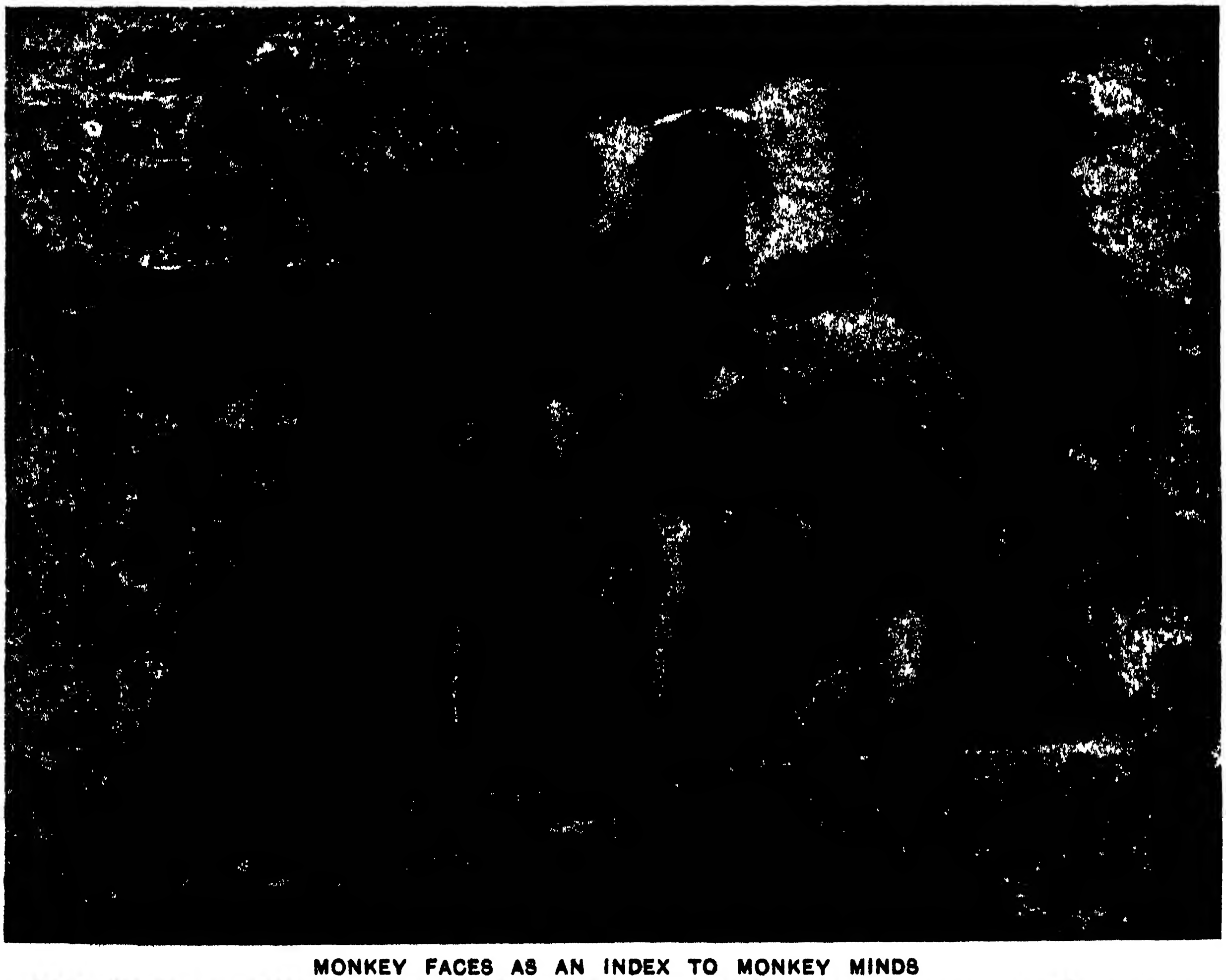
But to turn from the emotions of fear and anger, how do animals express pleasure? The most familiar examples are of course the purring of the cat as she rubs against you, and the delighted bark of a dog greeting his returning master, when he also displays his joy in every gesture of his body from his wagging tail to his shining eyes. The horse gives a little contented whinny as he gets what he wants, but the cow's means of expressing pleasurable feeling are poor, and limited to a general look of peace and contentment; unless, that is, she is so happy that she indulges in a little play and pretends to horn her neighbour in a practical joking spirit. I have never seen a fox wag its brush, but I have seen a tame vixen, when very pleased to see a friend, open her mouth in a wide grin, and with ears laid flat back run to meet her. The badger shows pleasurable excitement through its fur. I had two pet females once, that used to romp with the dogs—what mad games they all had together!—and little ripples of excitement could be seen running through their rough grey jackets, at one moment the fur of their shoulders standing on end, next that on the back, and as this flattened again the tail was fluffed out.

Autotype

THE DOG'S WAY OF LOOKING EXPECTANT

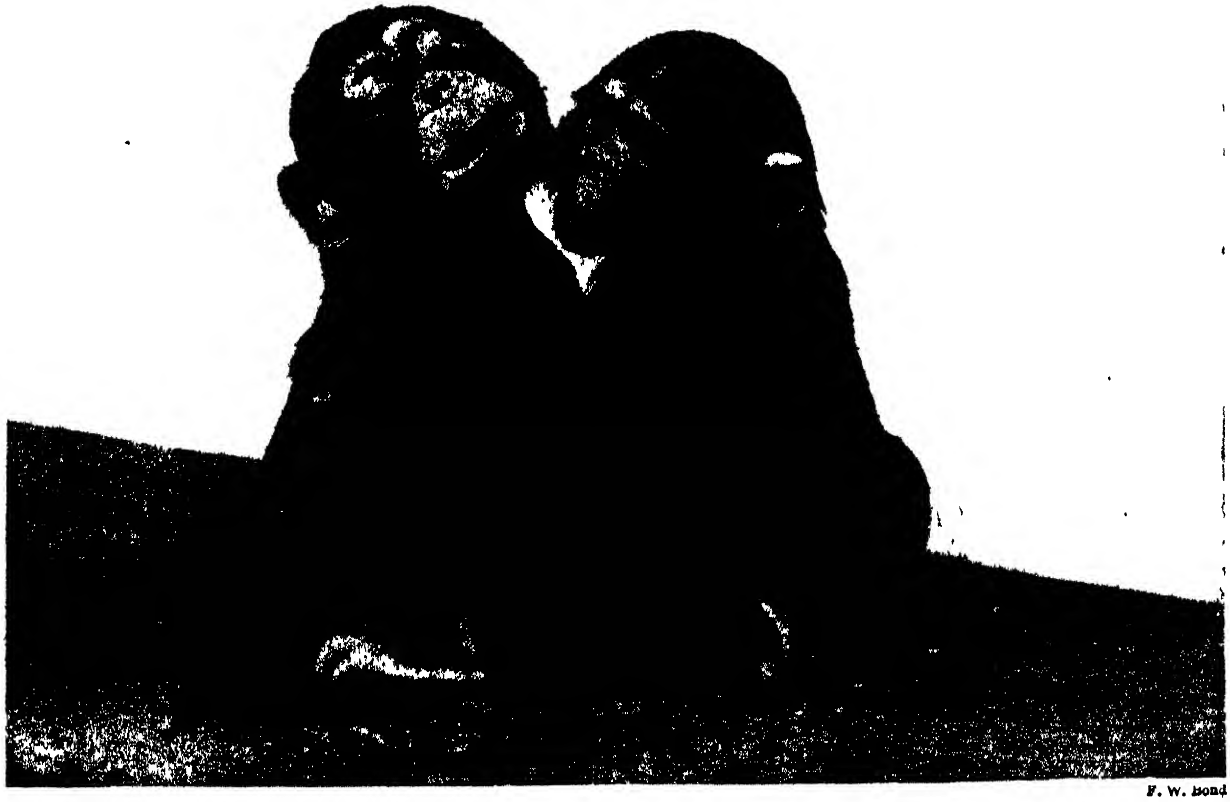
Dogs express their feelings much more effectively than cats. In this case the unusual procedure of being set upon a cushion and photographed has brought out the familiar twist of the head and the pricked ears which mean interested observation





MONKEY FACES AS AN INDEX TO MONKEY MINDS

Nothing could better express the languor of a warm afternoon and a temporary lack of interest in the scheme of things than the colossal yawn of the baboon here (bottom) on the Monkey Hill at the Zoo. A wide yawn in this case means the exhibition of a long oval of darkness beneath a snout that appears rather pig-like at this angle. The lip-less mouth is also very effective in the roloway monkey (top left), who is letting out a scream of indignation. Our remaining expressionist is a chimpanzee.



F. W. Bond

CHIMPANZEES CONTENT IN A MUTUAL EMBRACE

Of all the larger apes the chimpanzee is the easiest to tame and train for it takes kindly to human company and the opportunity of novelty and diversion which humans bring. Performing chimpanzees are common and people are apt to forget that this animal, which is so often made into a cruel caricature of human nature, has a real ape personality of its own quite apart from training. The attitude of affectionate companionship and complete content shown by the animals in the photograph is very striking.

Many birds, especially the hawks, show contentment by fluffing forward the soft little whisker feathers about their beaks. Nearly all birds when quite happy puff their feathers out a little, particularly owls, which then become a feathery ball. The brown owl has a most charming cooing call, (quite different from the loud penetrating hoot) which it uses when happy and pleased. It is one of the most caressing sounds I know, being even more so than the soft coo of the dove

At this point the reader may inquire if animals ever feel amusement, and if so how they display their feeling? It is commonly assumed that laughter is purely human and one of the proud distinctions of our race, marking the gulf that separates us from "the mere brute."

WELL, first, before considering the display of the feeling of amusement, is there any evidence that animals have the least sense of humour? The chimpanzees that put out bait, in the shape of breadcrumbs, to entice fowls near their cages so that they could poke them with sticks, and exhibited symptoms of impish glee at startling the unfortunate hens, as Professor Kohler tells us in his book, "The Mentality of Apes," would seem to have been animated by the same practical joking spirit as many a mischievous child.

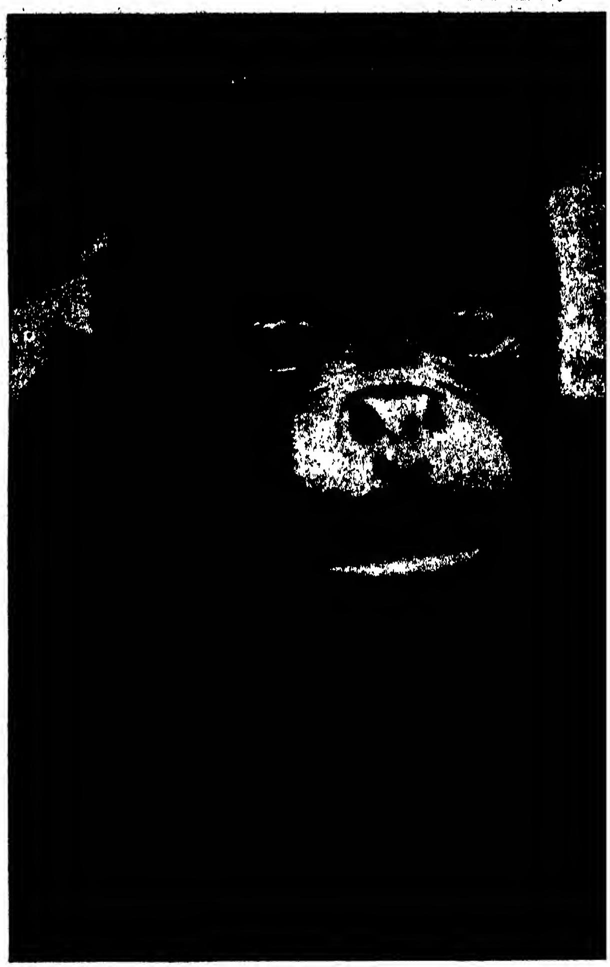
Then take the case of a dog, excellent friends with a cat, who took puss by surprise, by springing out at her from some grass, startling her so much that she bolted, raced to a post, jumped on to it, turned round and spat furiously at the dog, when the latter stood and grinned at her, looking hugely pleased. Or again take an instance of two otters at play in a pool. The female broke off the game and swam for the shore, when the male came quietly behind her, slyly nipping the extreme tip of her tail as she climbed up the bank, and in the same instant flung himself backwards out of her reach.

All these three episodes illustrate a spirit of fun, and as an eye-witness of the latter two, I can say that an expression of mischief was written plainly upon the features of dog and otter—which brings us back to the question, how do animals show amusement? Except in the cases of the highest apes, which sometimes contort their faces in grinlike grimaces and utter sounds not unlike laughter, obvious mirth of the human kind is unknown among birds and beasts. Yet the dog that chased the cat

Neville Kingston.

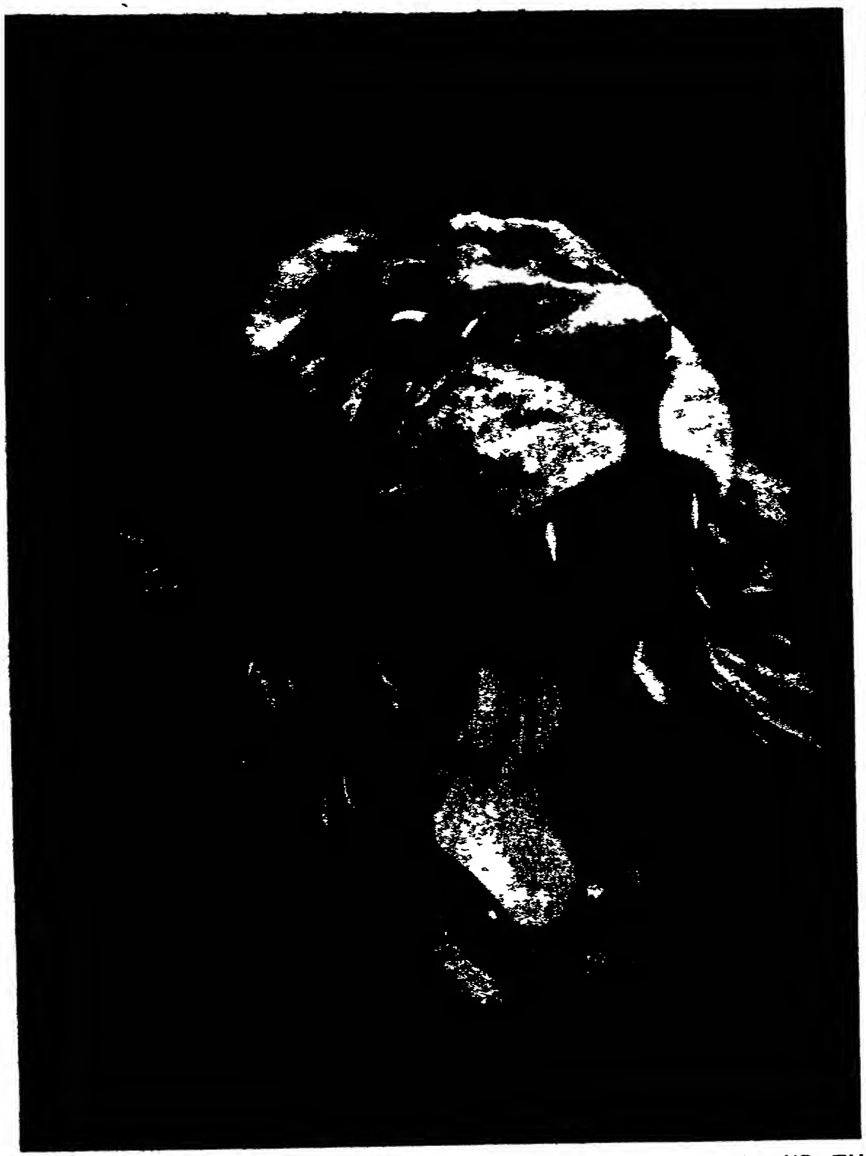
Natural History, N.Y

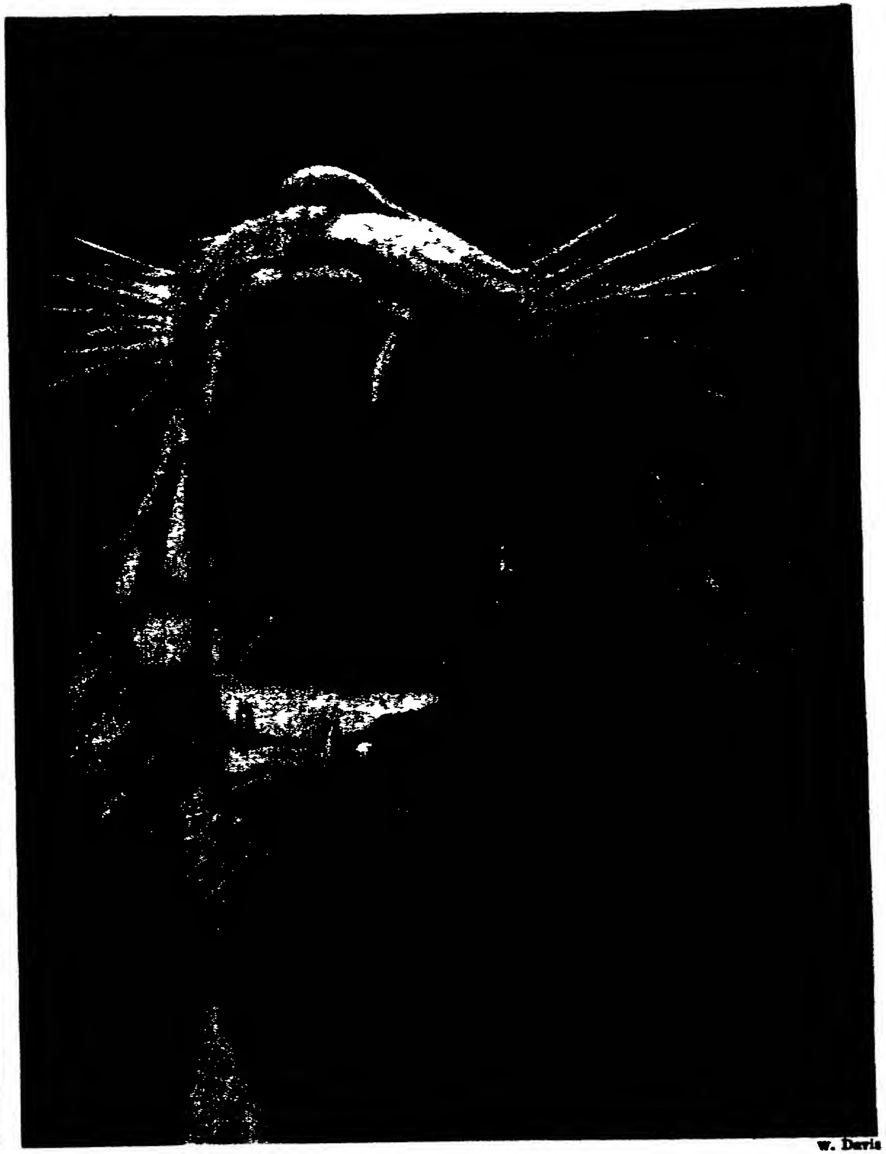
F. W. Bond



QUARTET OF QUAINT FACES FROM THE SIMIAN WORLD

The fascination of monkey expressions can be judged by the crowds that will stand for hours round the cages where these creatures are kept. It is not only the marvellous gymnastic displays that the smaller monkeys sometimes give which attract the crowd but undoubtedly their wealth of expression. Above we have some excellent examples of monkey faces: Humboldt's monkey from South America (bottom right), orang-utan from Borneo (top left), Red-faced ouakari (bottom left), and Proboscis monkey (top right)





W. Davis

FRIGHTFUL FANGS OF THE LION AND THE TIGER EXPRESS THE MENACE OF DANGER

The lion and the tiger, the largest of cats, leave no doubt as to their intentions when they wish to show anger. The bristling whiskers (see p. 66) the ears laid back, and those terrible rows of deadly white fangs constitute nature's most effective reading of the word "menace." In spite of traditions which make the lion the king of the beasts and a synonym of bravery, the tiger is undoubtedly the first in ferocity and is also more dangerous. It can beat the lion in agility, and the way in which it uses its frightful claws gives it an added advantage. Also, it should be remembered that a tiger can break the neck of an ox at one blow of its paw. These two beasts are certainly lords of their respective jungles.

Mr. & Mrs. E. H. Baynes

HOW THE COYOTE LOOKS WHEN HE HOWLS HIS EVENING HYMN

To point his nose to a star, lay back the head, open the fanged jaws to their utmost, fill the lungs and then howl and howl into the evening sky seems to fulfil a burning need in the coyote or prairie wolf of North America. The fur is much longer than that of the timber wolf and the tail much more bushy. The coyote flourishes in Mexico and in Texas, and other of the southern states of the U.S.A. It is harmless to man unless, perhaps, when cornered or with its young but is a great raider of chicken runs.

did look immensely amused, as did the otter that had teased his mate; their expression, however, lay not in grimace, but in the tense attention of attitude and sparkling eye. I remember a fox-cub which also delighted in teasing a cat, and the same joyous mischief was apparent in the cub's bearing.

Thoughtful attention is more easily deciphered, the pricked ears and steady stare of an attentive dog, likewise the pricked ears of the horse, tell the story of attention fixed on some object. The rabbit, hare, fox and wolf also betray their thoughtful study of anything by pricked ears, sniffing nose, and eyes directed towards it. The ears of wild animals are wonderfully expressive. Watch rabbits feeding at the covertside in an evening, and note those long, sensitive ears, now pricked in eager attention directed towards other rabbits, anon cocked to listen for danger, and then laid back in relaxed ease, all bespeaking the stream of rapid emotion.

Perhaps the horse's ears are really the most eloquent. Watch the way they move, now pointing ahead, pricked in eager interest at what is coming, then laid back, now one forward, one back, then relaxed into indifference, only to be suddenly laid right back, obviously in response to a feeling of quick annoyance because his comrade has touched him unexpectedly. The great ears of the elephant are also eloquent in expressing their owner's feelings, and one might multiply instances of expressive ears almost indefinitely, but there are many creatures whose ears are far from sensitive registers of the emotions. Their ears do not tell us much about the feelings of rats and mice, but these latter show nervousness in a peculiar way, namely by washing their faces. The dainty, sleek-coated, slim, dark-eyed fieldmouse always cleans itself after an alarm, passing its tiny handlike paws over head and ears with lightning rapidity.

Fear is "registered," as they say in the cinema, in a variety of ways. Monkeys pull piteous faces, and try with deprecatory gestures to ward off punishment, dogs crouch and cringe, while other creatures betray apprehension by their furtive, slinking gait.

It is a problem for the student of comparative psychology to determine whether animals can have any idea of right and wrong, but I have often seen moorhens, those handsome black, white and grey water birds, acting as if they knew they were doing wrong and feared the consequences. In the early

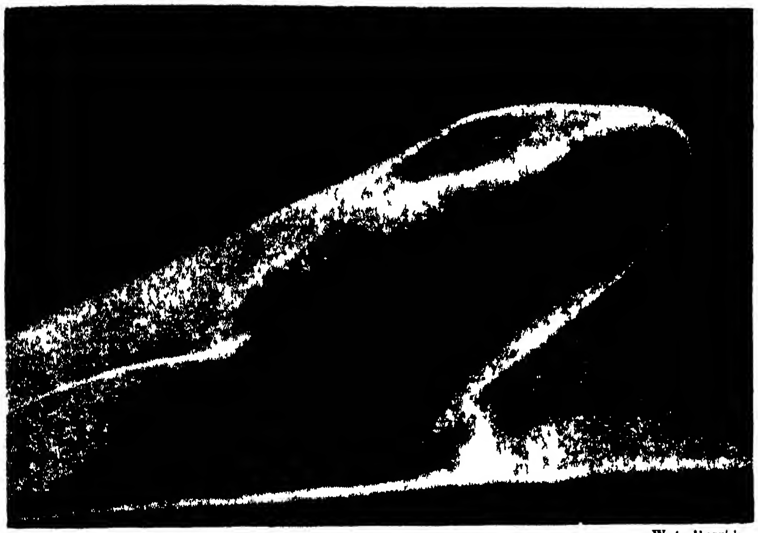
spring each pair of moorhens selects some area of pool or marsh on which to nest, and trespassers are prosecuted, not with the rigour of the law, but the rigour of beak and claw. I have often watched invading strange moorhens and noted their guilty, frightened air, as if they were well aware they had no business to be there, and knew they were likely to suffer the full penalties of trespassing. And when detected the intruders did not fight with anything appoaching the vim and determination of the owners of the pool, who appeared to be animated by feelings of righteous indignation.

That chimpanzees are aware when they have done wrong is testified to by Professor Kohler, who tells us that the guilty air worn by his apes, with their deprecatory manner, was often the first indication they had been in mischief. I have several times known a dog give himself away by his guilty manner, coming cringing to his master, completely betraying himself before the latter had any idea the retriever had been off hunting with another dog. Of course, in the foregoing paragraphs, I have been referring to pure fear undiluted with anger, but fear and rage mixed form the emotional background of

Autotype

NOBLE SOLEMNITY OF THE "KING OF BEASTS" IN CAPTIVITY

Curiously enough it is the caged lion which grows the largest mane and the mane is the lion's glory. Thus framed the head expresses perfect dignity as the animal, which may weigh as much as five hundred pounds, gazes at us through the bars of his prison—kingly even in captivity. But even Homer was said to nod, and this great beast, which a moment ago turned on us a royal gaze, will suddenly emit a vast yawn so like a cat's as to seem a little undignified But the dignity is soon resumed again.



W S Berridge

FACES WHICH EXPRESS THE LIVES OF THEIR OWNERS

One would hardly go to the dogfish (top) for emotion as expressed by the face. But this cold eye that never blinks and the mouth that only opens to breathe and feed are adequate expressions of life in the dim waters of the sea The tortoise opens its mouth in anger but otherwise is little more lively His face matches his life

some of the most ferocious displays, such as the savage exhibitions of various wild cats already mentioned. It is fear which moves them to anger.

Turning to a different type of feeling, sadness and low spirits are always apparent, but one sees them only among captive creatures which, with nothing to do, and perhaps not in the best of health, have time to mope and be sad. Healthy, busy wild animals, employed in getting their own living and caring for their young, never suffer from depressed feelings; they have no time for sorrows!

I am referring here to adults young creatures awaiting the mother's return, or temporarily separated from her, are often quite frantic with anxiety Watch the calf bleating for its dam, or a lamb that has lost the ewe, or, again, a young hedgerow bird chirping for the old one, and it is obvious that their whole being is one great anxiety. "Mother! Mother! Oh, where is mother?" Thus in our words we may epitomize their feelings. Is there anything more pitiful than the grief of a baby creature taken from its parent? Its sorrow may quickly pass, but in the meantime how the poor thing suffers, crying incessantly for her, its whole appearance betokening woe and anxiety.

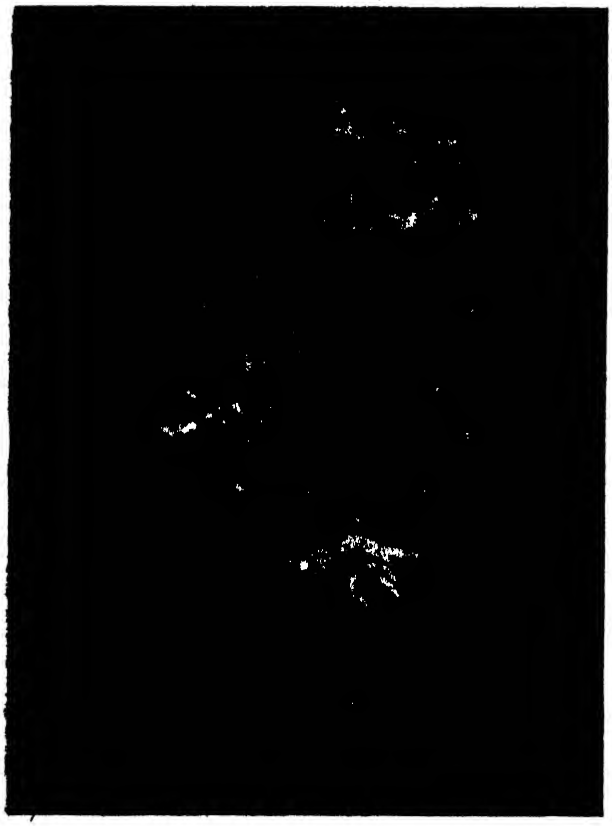
SEPARATION from a well-loved comrade is nearly as bad. Monkey friends grieve greatly when parted, their sorrow depicted in doleful expression and loud lamentation; but the most enduring grief I have met with among animals was displayed by Madame Moses, my pet otter, when her sister ran away and she was left alone. The two had been inseparable and the most devoted of companions going everywhere and doing everything together, from getting into all sorts of mischief and romping madly together, to sleeping in each other's arms in the most loving embrace. Then Miss Aaron ran off with a wild otter, and poor Moses was left to fret miserably for her She whimpered and cried, she sought the truant far and wide, she came to me and climbed into my arms, there whimpering herself to sleep, only to wake up and resume the hunt for Aaron. For days she was inconsolable, and it was some time before she was her old lighthearted self. Poor thing, she expressed her feelings clearly enough!

Expectation, especially anxiety for food, is usually so plainly expressed as to be unmistakable. The open-beaked demands of a young bird are such that all the world knows its needs, whether it be a young cockatoo shrieking its demands or a nestling cuckoo urging with insistent squeaks its poor little foster parents to greater efforts on its greedy behalf. The expression of eager anticipation in young birds is not only depicted by the open beak, but by the fluttering of wings which seems to add insistence to their demands.

This fluttering of the wings is a sure token of expectation. I have seen an old raven, who thought he was going to secure a tit-bit, flutter his sable pinions like a nestling; and likewise a female blue-tit wanting to feed her young in the nest, and delayed by her mate who was delivering his supplies, flutter her wings in eager anxiety to get on with her work.

Natural History, N. Y.

F. W. Bond



American Museum of Natural History

BIRDS WHICH STRIKE TERROR BY THEIR APPEARANCE: JAMACIAN, BARN, AND EAGLE OWLS

While just sitting on a branch the eagle owl (bottom left) looks terrifying enough, but when disturbed (bottom right) the bird takes on an appearance that is positively startling in its combination of the horrifying and the grotesque. There is something about it which suggests the weird imaginings of those medieval craftsmen who devised gargoyles. Above are a Jamacian owl (top left) and an English barn or screech owl which is so often seen like a dim white ghost, flapping in ominous silence over the evening fields.

Neville Kingston

SPIT-FIRE FEROCITY AS THE WILD CATS SHOW IT

For sheer savage hatred the cat family is hard to beat. The lower photograph shows that rather rare specimen, the caracal, whose name is a French corruption of the Turkish Kara Kulak, "black ear." The animal is related to the lynx and is found in Southern Asia and in Africa The Scottish wild cat (top) is the only member of the cat tribe left wild in Britain. It seems to have existed in North Wales and the Lake District until the nineteenth century but is now found only in the wild mountains of Scotland

Natural History N Y

POMPOSITY HIGHLY INDIGNANT: THE FURIOUS COCKATOO

For a study in self-important exasperation we need go no further than this photograph of an enraged cockatoo The family to which it belongs is native to Australia and the adjacent islands, and a feature distinguishing the species is the handsome crest which ordinarily lies back on the head, but, under stress of anger, resembles the head-dress of a Red Indian.

Wing fluttering is a sign of both expectancy and anxiety. It is nearly as eloquent as the wide-open beak, which it usually accompanies, as one may so often see in the case of pelicans expecting their dinner at the Zoo—the great beak open in mute appeal, and the eager wings enhancing the effect of anxious expectancy. Nearly as eloquent in the display of anxious feelings is the open-mouthed attitude of a hippopotamus begging for offerings. That displays expectancy as clearly as anything can.

Now, longing of a different sort—namely, to meet with a mate—is depicted in many ways, usually very striking, whether vocal or visual, for in courtship and love-making animal emotion reaches its highest pitch. The wonderful displays of many gaily plumaged male birds, from the cocks of the different magnificent birds of paradise, the argus pheasant, and the peacock, to that of the humble blackbird, are all the outcome of the intense excitement which thrills their being. Their feelings are so great they must give vent to them. Emotion wells within them until they strut in ecstasy. Watch a peacock displaying his wondrous fan, and note how he sets it a-quivering as waves of passion thrill through him; it is not a display of vain self-conscious pride but a display of passionate emotion, just as the songster is lost to all thought of self when he pours forth his paean of joy.

Song, too, is an expression of emotion—the joyous excitement of the spring that possesses the bird to the exclusion of all else. Even mammals have their love songs, from the wolf howling in the forest, the coyote on the plains, to the dog in the back-yard baying at the moon. And, as in birds, they lift up their voices to express their feelings and give vent to the surging emotion that wells within them. The tom cat screeching beneath our window at night is expressing his feelings, just as the fox out in the woodlands gives vent to his in a little, short, gruff bark—and so one could go on, giving many examples of the weird ways in which the most intense animal feelings, namely the emotional outpourings connected with courtship and mating, are displayed in beautiful posturing, extraordinary antics, and vocal outbursts, both impressive, awe inspiring, and charming.

Most wild creatures live in the present, time for them being limited, for they do not look far back nor yet far ahead. Hence the rapid stream of their emotions is one of fleeting impressions, as fleeting as cloud shadows racing along a hillside, and the expression of them as quickly variable. They fling their all into each passing phase, there is no posing, make believe, or acting about them; so in the expressions of animals we see depicted real emotion, and let us not blind ourselves to the intensity of the feelings thus expressed.

Chapter IX

Skeletons: & Some that are Worn Outside

By W. P. Pycraft

Author of "The Seashore,' "The Courtship of Animals"

THE very mention of the word skeleton suggests to most people something gruesome—an idea begotten of the fact that a skeleton is never seen except after the dissolution of the body. We have a feeling of sympathy with Ezekiel, who, when standing in the Valley of Dry Bones, was asked: "Can these bones live?" For it seems impossible that anything of interest can ever be said of them.

Look at a human skeleton, mark the fine lines of the frame-work on which our glorious bodies are built up; and then ask—whence comes this frame-work?

To find the answer to this question we have to go back to the simplest of the Vertebrates. Let us take that tiny, translucent little creature the amphioxus, a creature even more primitive than the lowliest fishes. It reveals to us the simplest form of skeleton to be found among the Vertebrates. The function of that skeleton, it should be remarked, is to furnish attachments for the muscles which affect the movements of the body. These must have some fixed point to work from, and this is furnished by a long, slender, unjointed, fibrous rod running from one end of the body to the other, and is known as the notochord.

Above it runs the spinal nerve-cord supplying the nerves which drive the muscles into action. Below it runs the main blood-vessel of the body. Such is the ground-plan of the Vertebrates, as distinct from the Invertebrates, wherein the skeleton is outside the body, and the nerve cord runs down the ventral surface instead of along the back, which is traversed by the main blood-vessel—an exactly opposite arrangement to that of the Vertebrates But of this we shall see more presently.

The next stage in the evolution of the skeleton we find in the shark tribe, wherein the noto chord has become surrounded by a series of bony rings. Here we have the first vertebrae. The skull, at present. is a mere gristly or cartilaginous box, with special enlargements for the brain, eyes, and organs of smell and hearing. To its underside is hinged the lower jaw.

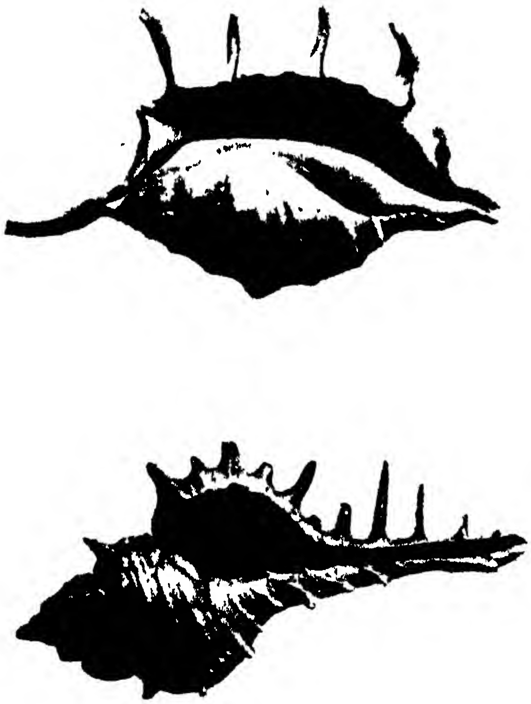
In the primitive land-vertebrate like the newt, for example, a bony skull has taken the place of the gristly box; bony hoops, forming the ribs, encircle the lungs and heart; and outside this cage we find the bony limb girdles and the limbs attached thereto.

Here we have a primitive Vertebrate, condemned to crawl on all fours.

Man alone walks always upright. His fore-legs have become glorified into arms and hands, ready to carry out the behests of his brain. Superb in the exquisite poise and beauty of his body, almost God-like in his knowledge, lord of "the beasts that perish," he is yet, all too commonly, the most brutal, and the biggest "beast" that the world has yet known, or is likely to know!

When we come to survey the Vertebrates, group by group, what an immense range of form and size we find. What have been the moulding forces which have resulted in this bewildering variety? We must reply the "shifts for a living," in the struggle for existence. In the scramble for food fresh sources of supply have had constantly to be tapped. And these have acquired constant adjustments of existing structures in response to the new conditions of capture, or of consuming and digesting the new type of diet.

These "winners in Life's race" we see in "the fowls of the air. and the beasts of the field, and the creatures under the earth," as well as in those under the waters. Fins have become legs, legs have become wings. And there are legs for every possible service; walking and running legs; clawing and digging legs; climbing and swimming legs. And all these have come into being only



S.C Johnson

SKELETONS OF WONDER

Protection has been sought by the mollusc known as the Venus shell (below) in the forming, out of what was originally its skeleton, of a beautiful covering for the otherwise defenceless creature. The scorpion shell (top) shows active defensive properties in its curved spikes

by slowly modifying the hand or foot of the moment By slow degrees the webbed foot has become the flipper of the turtle, or the whale. If we examine the records of the rocks we can see how, in the course of time, the five-fingered foot of that strange creature phenacodus became the one-toed foot of the horse.

Everywhere we find that the size of an organ, or any part thereof, increased as the work demanded of it; and on the other hand we see how organs, or parts of organs, shrink in size, till they become mere vestiges, and finally disappear as a result of disuse

Such are the factors which have given us one of the most remarkable of all the Vertebrates—the tortoise Familiarity, we are told, breeds contempt. If the tortoise were an exceedingly rare animal we should have discovered long since what a wonderful creature it is. Now we merely say of it that it is a creature which lives in a shell. But how has that shell come into being? Wonder of wonders, it is the skeleton which has worked itself out of its body!

W S Berridge

PRAWNS AND SHRIMPS IN THEIR JOINTED ARMOUR

Like a miniature lobster the prawn (below) frequents pools among the rocks while the shrimp (above) swims in its millions forming food for innumerable fishes. An examination of one of these creatures, even after it has been boiled, will reveal the simple but extraordinarily effective armour which has been slowly evolved out of what was once an internal skeleton.

This remarkable state of affairs began when the ancestral tortoise started to develop an armour-plated skin, formed of bony nodules covered with a sheath of horn, after the fashion of the back shield of the crocodile.

As that armour increased in weight and size it gradually restricted the movements of the backbone. As a consequence the muscles of the back, having less and less work to do, gradually dwindled away, at the same time lowering the back shield on to the ribs and spine. But matters did not end here. The sinking process went on till at last the great back shield and the ribs became welded together to form the shell of the tortoise as we see it in specimens great and small to-day.

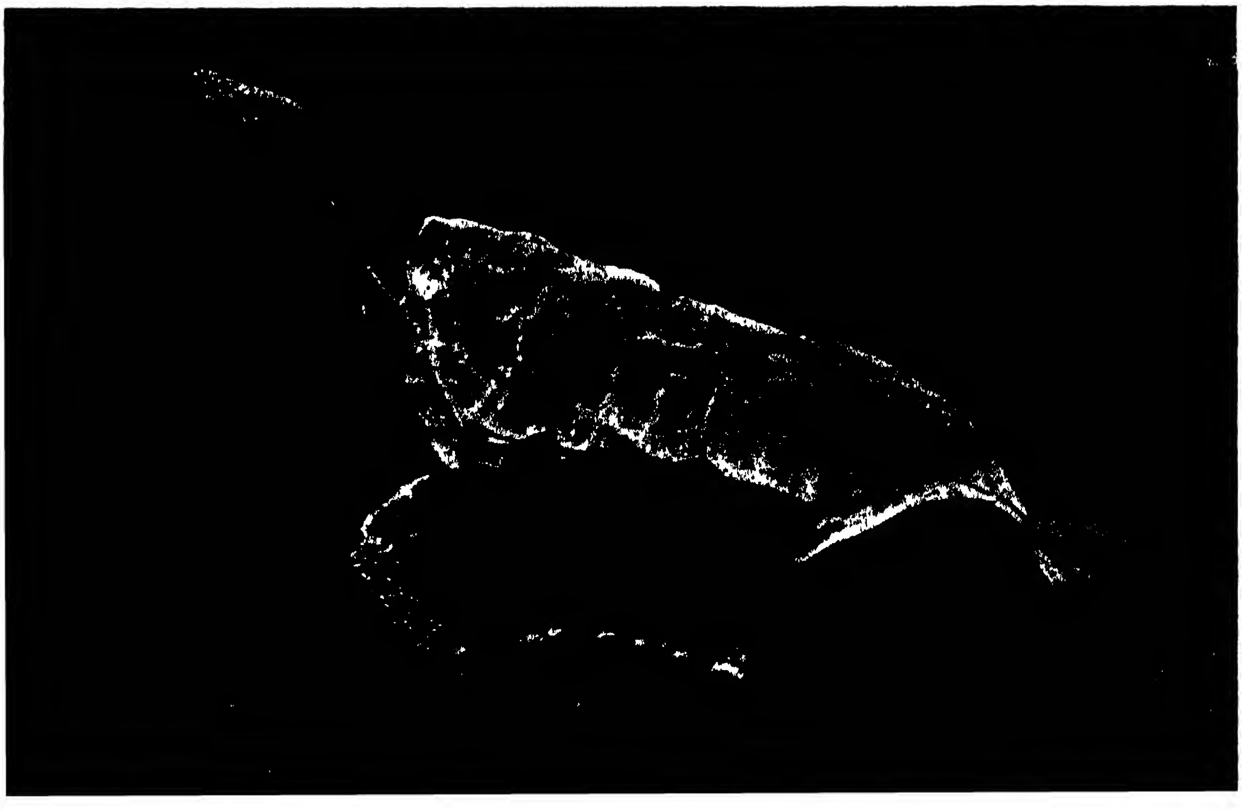
It should be carefully examined; for it presents some interesting features. The bony skin-plates have become beautifully interlocked with the ribs, while down the middle of the shell roof may be seen the tops of the spines of the vertebrae. But further, the horny plates have an arrangement of their own; and along their edges the bony shield is deeply scored by grooves, forming a pattern superimposed on that of the bony shell itself.

There is yet another strange thing about this shell. In all the other land-vertebrates the shoulder girdle lies over, outside, the ribs In the tortoise it has come to lie under them, and therefore inside, rather than outside the body!

The great, broad breast shield, in like manner, has come to lie outside the body; for its outer surface is covered by no breast muscles, but simply by the horny scutes of the skin.

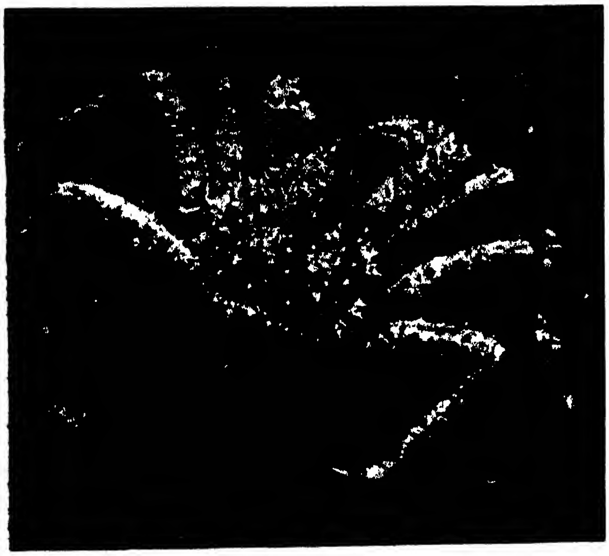
That this strange shell was developed as a protection against enemies there can be no doubt; for the creature, when alarmed, will withdraw both head and limbs within it, and thus defy all comers. But the extinct giant tortoise of Abingdon Island had the good fortune to live where there were no enemies to guard against. And so, as a response, the anterior aperture of the shell opened out, to form a great wide

W. S. Berridge



TORTOISES PROTECTED BY THEIR ADAPTED SKELETONS

By modifying the physical structure to new needs certain races of creatures have survived. Those who could not so adapt themselves perished. Witness the Abingdon Island Tortoise (bottom), which has a remarkably long neck and a much thinner shell than is usual with tortoises. It inhabits Abingdon Island, one of the Galapagos group (known also as the Tortoise Islands), which lies in the Pacific some 695 miles west of the coast of Ecuador. The upper photograph shows an Elephant Tortoise with a Greek tortoise placed on the shell.

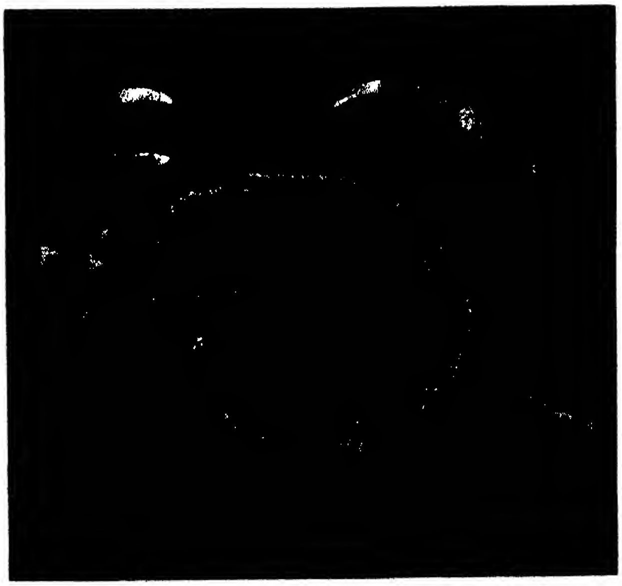


Edible-Crab

King-Crab

Land-Crab

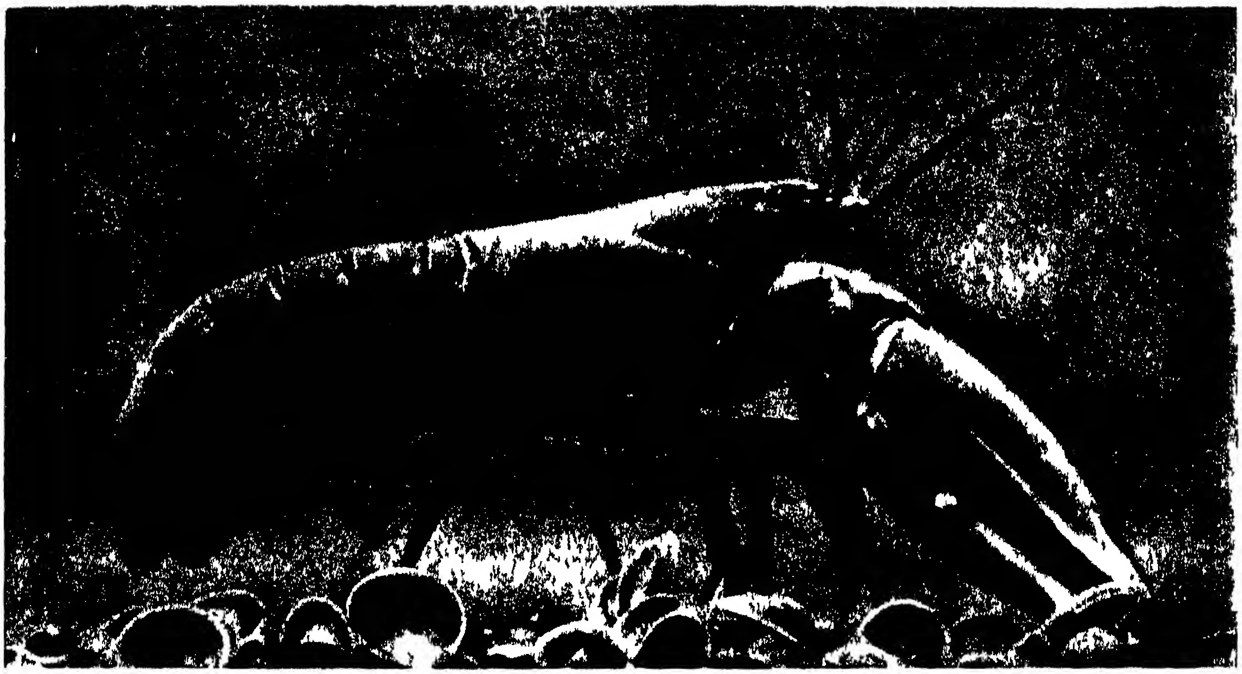
Spider-Crab



Sponge-Crab

HOW THE CRAB SOLVED THE SKELETON PROBLEM

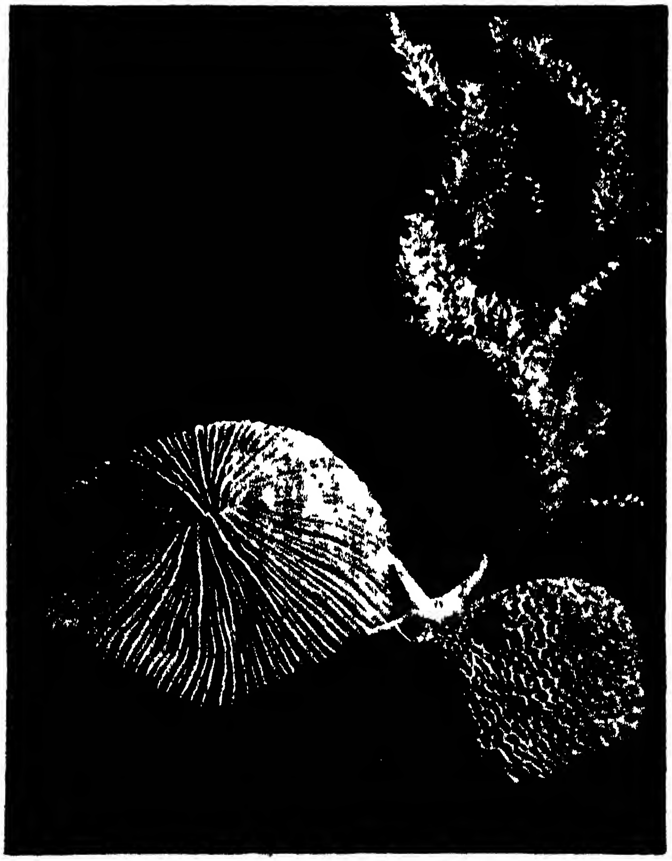
A few examples of that group in the animal world which is called Crustacea are familiar enough on fishmongers' slabs, but there are many other representatives which the public never see. There is a great variety among the crabs alone which is apparent from the above photographs. But all have this common feature that the limbs are jointed and the skin has become hardened to form at once a protection and a skeleton or basis from which the body can be built up. The Photographs are by W. S. Berridge & E. Step



Neville Kingston

SIMILAR PROTECTIVE DEVELOPMENT OF CRAWFISH AND LOBSTER

Here we see a truly marvellous development of the skeleton into something far more protective than in the case of the shrimps (see page 78). The intensely hard plates have not become welded into an immovable mass, as in the case of the tortoise (page 79), but are flexible like the suits of armour man devised in the age of chivalry. The crawfish (bottom) which is seen standing erect, must not be confused with the fresh water crayfish. The lobster (top) is seen walking with bent legs on the floor of its tank. Both photographs were taken through the water



MARVELLOUS HABITATIONS OF THE CORAL

The lower photographs of species of Indian Coral and the upper of some from the China Seas, show the extraordinary variety of this miracle of the sea These communal skeletons may resemble the under side of a mushroom, or a sponge while some seem to imitate frost formations

doorway. Though this left the heart and lungs protected by no more than a sheet of soft skin this was a matter of no importance, since there was nothing on the island that could hurt it.

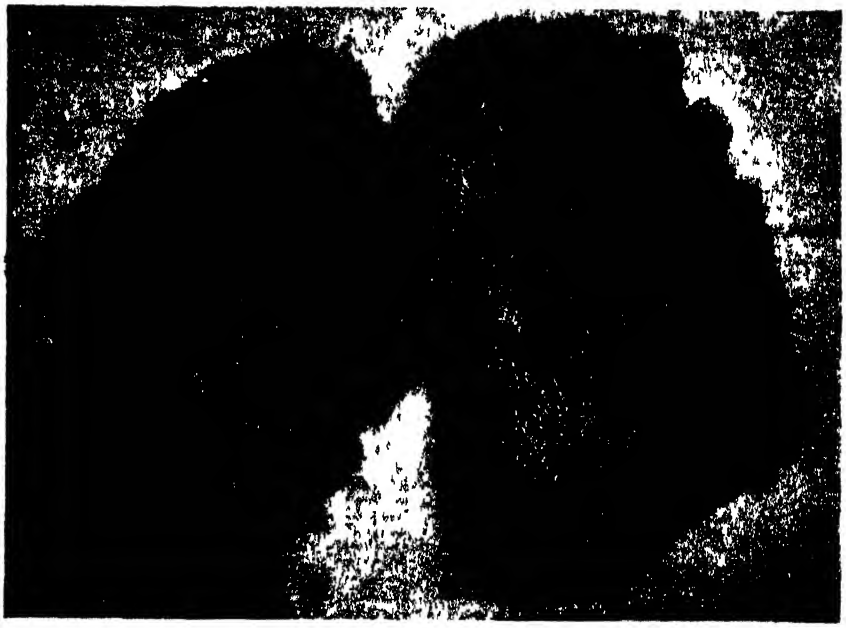
In some of the water-tortoises of the genus *Trionyx*, again, the need for a heavy shell has passed, and so it has become almost entirely replaced by a great leathery shield. Cause and effect are very well shown in the tortoises.

When we turn to that other great group of the animal kingdom, the Invertebrates, we find an external skeleton to be the rule, not the exception. No better example of this type can be found than that furnished by the lobster, which is encased in what we may call a stony shell. And like the armour of ancient warriors, to afford freedom of movement for the body and limbs, that armour is wonderfully jointed. The muscles run from the walls of this shell to the parts which have to be moved, thus exactly reversing the order seen when the skeleton is internal.

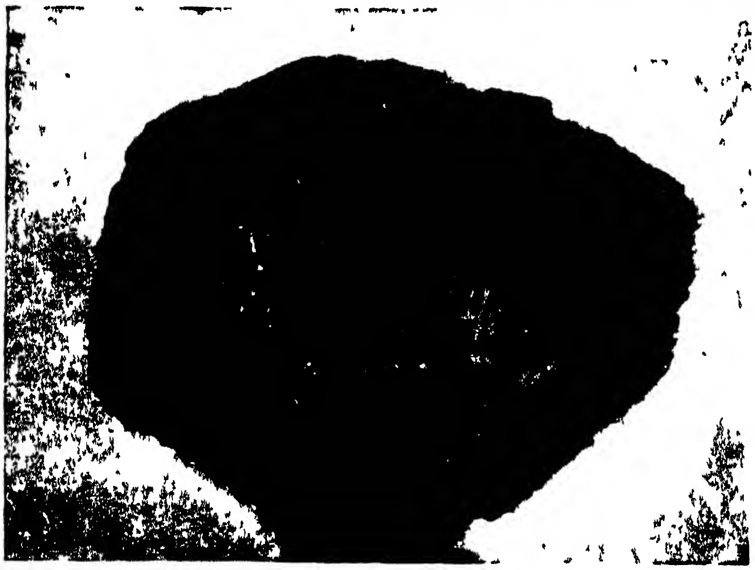
If the Invertebrates had been limited to lobsters and crabs, prawns and shrimps, we should have said that only by hardening the outer wall could an efficient hold for muscles be obtained. But Nature is always achieving the impossible. And so we find that soft-bodied caterpillars are able to move about quite as easily as the hide-bound lobster.

The molluscs have an external skeleton, often of wondrous beauty, as witness the cabinets of the shell collector. But here that skeleton is solely for the protection of the body; a

defensive armour. The body within it has a quite soft exterior. But there are a number of species which have contrived to discard the shell, as in the case of the nudibranch mollusca. Here the protection is afforded against enemies, either by warning or protective coloration. Some, however, like the slug and the squid or cuttle-fish have withdrawn the shell within the body like the Vertebrates.



In some of the cuttle-fish this shell takes the form of a long, thin, horny, blade-like plate, known as the pen; in others it is of a calcareous character, a long oval, and of considerable thickness. This furnishes the cuttle-fish bone hung so commonly in the cages of small birds to enable them to keep their beaks in good order. The so-called thunderbolts found so commonly in fossiliferous deposits are the pens of ancient and long extinct cuttle-fish.



E Step

THE COMMUNAL SKELETON OF THE CORAL

Here we have one of Nature's greatest marvels. Minute, soft-bodied creatures, beautiful in form and colour, have contrived to win in the fight for life by building up, from the sea and the organisms that swarm in it, community skeletons to such an extent that a considerable portion of the world's surface is composed of them.

Though an external skeleton representing but a single individual is the rule among the Invertebrates, there are one or two groups which have a complex and much-branched skeleton shared by a large number of individuals. These are to be found among the great companies of creatures known collectively as the polyzoa, hydrozoa and anthozoa.

Everyone, when at the seaside, must have examined with some curiosity pieces of seaweed of horny texture; sometimes beautifully branched, sometimes looking something like a bottle brush. These are not really seaweeds; but the final relics of what was once a flourishing colony of polyzoa animals, so soft-bodied that but for their ability to build up this common dwelling, which we might liken roughly to a series of flats, they would never be able to rise above the sea floor. A branch of one of these colonies, seen under the microscope, would reveal numbers of tiny bodies protruding half out of a delicate crystal cup projecting from a tubular stem, each little body surrounded by a crown of waving, glassy tentacles. Here the skeleton is outside the body.

The hydrozoa include not merely the familiar jelly-fish, which very emphatically has no skeleton, but also a large number of types, such as the horny-corals, and stone-corals, which have a very remarkable skeleton, sometimes of stony hardness

The horny-corals and the stone-corals are creatures closely related to the sea-anemones, and very similar in shape, but forming colonies, building up internal skeletons of rare beauty. Such skeletons, it is to be noted, do not belong to the individual, but are formed by the whole colony as it grows. Their bodies form a common fleshy investment. Here, then, we have an entirely new kind of skeleton, and once more an internal skeleton.

Such skeletons have played, and are playing, a great part in the history of the world. A large part

of its surface is made up of their fossilised bodies. They have formed, and are forming, islands in mid ocean, and vast " reefs," like the Great Barrier Reef of Australia, hundreds of miles long.

An immense amount of knowledge has been gained as to the habits and structure of these world builders; but we still seek in vain for an explanation such as will account for the bewildering variety of the shapes their stony masses assume. Some branch like trees; some assume the form of mushrooms; some form huge boulder-like masses with the surface covered with meandering ridges, reminding one of the mountain chains on a map.

The soft bodies which contrive to build up from the sea-water, or the food contained therein, these protean forms are strangely beautiful in their form, and varied in the brilliancy of their coloration. They seem to set the tone, so to speak, for the fishes, and other free-moving creatures which surround them. More than this, many of the fishes have become structurally modified, as to their jaws, for the purpose of feeding on them.

Though in British waters there are no coral reefs there is at any rate one species of coral in British seas. This is a species of *Caryophyllum*, which is to be found attached to shells near the Eddystone Lighthouse, and other places in the English Channel, as well as between tidemarks in the Scilly Islands and off the Shetlands.

One of the most highly-prized skeletons in the world is that of the red-coral of the Mediterranean. Deep down, from forty to a hundred fathoms, its crimson branches spread out, starred with little flower-like bodies. These are the coral builders. Their tiny bodies, all intercommunicating one with another, slowly transform carbonate of lime drawn from the sea water into the stony tissue we know as the red-coral. When this is first brought to the surface the " bark " formed by these jelly-like bodies is stripped off, and the outermost layer of the branch is filed away. Afterwards it is ground with emery-powder and finally polished with steel to form the beautiful beads and other ornaments looking rather as though made of wax than of a substance as hard as stone.

Though we can dissect and classify these singularly diverse types of skeleton, and the polyps or bodies which build them up, we are yet unable to discover the secret of their being. Each of these separate polyps is to all intents and purposes a sea-anemone. When and why did the first corals begin to anchor their bodies down to the ocean floor by means of a central core of stony hardness? Why did others go on budding out into new individuals attached by a common base, and sharing a common stomach, to break out, so to speak, into the innumerable types which form the stone-corals and the horny-corals and sea-pens of to-day? All alike are living in the sea, and all alike feed on the same kind of food—minute microscopic organisms. It is clear that there is an inherent difference in the qualities of their tissues, a difference of subtle physiological processes whereby, as in a chemist's laboratory, different substances are built up by different combinations of the same elements.

The red-coral, we have remarked, furnishes one of the most precious skeletons in the world, because of its extreme beauty after it has been suitably prepared by human hands. But there are other skeletons which run it very close, though we value them, not for their beauty, but for their usefulness. These are the skeletons of sponges. What should we do without our bath-sponge?

I need not enlarge upon the different types of sponges; we all know them well. But a knowledge of their nature is by no means so general. Those who would see for themselves what a living sponge is like have only to search the edges of slow-moving streams for small, more or less oblong patches looking rather like green felt. Gently remove such a patch to a glass bottle, and watch it through a magnifying glass. Minute particles of solid matter will be seen streaming into small holes in the surface. Much stronger currents will be seen streaming out of the large holes. The addition of a little colouring matter, dropped just over the patch, will make these movements more clearly visible.

The solid particles going in are food particles, and they are drawn into specially modified digestive cells to be converted, presently, into the tissue of the sponge. The emerging particles are waste products.

But the fresh-water sponge has no lasting skeleton. With the marine species this is quite otherwise, for most of these have a skeleton of horny fibres, or of horny fibres stiffened with simple, or branching, rods known as " spicules," microscopic in size, and as hard as flint. Many are very brightly coloured during life.

The living bath-sponge is not very attractive-looking, being of a uniform black, or slate colour. It is taken by divers, or harpooned, and when brought ashore is macerated in sea-water till the soft tissue, or flesh, rots away when the horny skeleton is hung up to dry.

Some of the sponges—of no commercial value—are of considerable size, and some are of great beauty, as for example the glass-rope sponge, which forms a long stalk of strands looking like spun glass. This stalk is thrust down into the mud, leaving the beautiful cup-shaped body well above the sea floor.

We began by discussing such skeletons as serve as points of attachment for muscles, which send out, so to speak, contractile bands to the several parts to be moved. These muscles, save in the case of the tortoise, invest the skeleton. In the Invertebrates, on the other hand, the skeleton invests the muscles; in either case the hard parts are intimately associated with movement.

There are exceptions to every rule. In the snails, and other univalve molluscs, the skeleton is but loosely attached to the body, and serves only as a coat of mail to protect an otherwise defenceless creature. What are the factors which have brought about

AWE-INSPIRING SKELETON OF THE GIANT DINOSAUR, TYRANNOSAURUS

Dug from the soil of Montana this colossal frame which the Tyrannosaurus developed is in the American Museum of Natural History A man, standing beside one of its legs, gives us a vivid idea of the gigantic size which this pre-historic animal attained This is a case of a normal skeleton developed to titanic proportions by the species—the Dinosaurs—which once were the most powerful beings on the earth The little mollusc (page 77) the Venus shell, adapted itself to changing conditions The Dinosaur failed—and perished

the astonishing range of beauty in the form and coloration of their shells we have yet to discover.

Finally, we have to consider skeletons such as can only be seen under the microscope, but which are indescribably beautiful. Some are made of lime, some of silica, looking as though they were of cut-glass of exquisite workmanship. Minute though they be, their dead, fossilised bodies make up vast areas of the earth's surface ; and their descendants are still at work. These are the skeletons of the foraminifera, and the radiolaria which exhibit an amazing variety of form.

THE foraminifera of which there are hundreds of species, number some giants among their ranks. Parts of the Egyptian desert are strewn so thickly with their disc-shaped bodies, nearly two inches across, as to make it difficult to walk over them, because they slide about under the feet. These, and the smaller species, form enormous areas of limestone in various parts of the world. And this is largely used for building purposes. They bear witness, also, to stupendous changes in the earth's surface, as we may gather from the fact that this limestone forms part of the mighty Himalayas, 19,000 feet above the sea level. They once covered the sea floor. The chalk cliffs of Dover are built up of their frail bodies ! Microscopically examined these shells are seen to be perforated with minute holes. Through these are thrust delicate strands of protoplasm, the stuff of which the living tissue is made, and which forms the shell. This protoplasm, in the form of long, delicate threads, at one and the same time serves as oars and hands to capture food.

The jelly-like substance, or protoplasm, of the radiolarians is in all essentials like that of the foraminifera. Yet it possesses qualities we cannot detect ; qualities which make possible the formation, from the sea-water, of fragile, translucent skeletons of flint-like silica ; these shells are of marvellous beauty.

They swarm to-day in all the tropical areas of the ocean, and have been closely studied by men of science, who tell us that these shells are, for the most part, composed of a central capsule, enclosing the more vital part of the protoplasm, since it contains the nucleus and oil-globules which help to keep them afloat. Around this is an outer shell, the two being held together by radiating rods of silica. Over this outer shell is a layer of jelly, and from this proceed innumerable pseudopodia, or threads, for locomotion, and the capture of food. Moreover, during life this outer region of jelly is often most brilliantly coloured.

The spherical shells with their radiating rods recall the wonderful ivory spheres carved by the Chinese into a sort of filigree work. Their range of form is truly astounding.

John J. Ward

BEAUTIFUL SPIRAL CASING OF THE GREAT TRITON

Painters of mythological pictures were very fond of introducing this shell into their canvases as an instrument for the attendants of the sea-deities to blow. The shape and formation have a most beautiful design from the top of the cone to the ringed aperture. Some of the markings show successive stages of growth, the shell, the triton's adapted skeleton, becoming gradually thicker. It is interesting to note that the Polynesian islanders still use the triton shell as a trumpet for religious ceremonial.

Chapter X

What Comes Out of An Egg

By Dr. C. G. Patten

Professor of Anatomy, Sheffield University

"WHICH comes first, the hen or the egg?" Perhaps a poser for some of us, but certainly not for the student who possesses even an elementary knowledge of biology! He knows that the forces of evolution proceed always from the simple to the complex; from *homogeniety* to *heterogeniety*.

The egg, compared with the parent, is a very simple organism, composed in the main of thin gelatinous material called protoplasm, the basis of all living matter. Yet this egg possesses marvellous potentialities not only in the direction of growth and development, but also of heredity. When we consider, not only the structural uniformity of the egg, but also that embryos of various animals in their earlier stages are practically indistinguishable, we marvel at the *vis a tergo*, which, in the elaboration of varied and manifold processes, insists on like begetting like.

For the sake of argument we might possibly conceive of the earlier stages in pre-natal development being mechanical (seeing that all embryos are so alike); indeed we might, so to speak, conceive of them being "cast in the same mould." But in the later stages the conception of mechanism is ruled out of court. The exact impress of the particular parent, portrayed towards the termination of pre-natal existence, must have some other force behind it. It is impossible, for instance, to explain specialisation of the form of the limbs in different animals on mechanical grounds. All limbs arise alike: but compare the vast difference in the hoof of the horse, the flipper of the whale, and the hand of man. These are simple examples out of hundreds of others. This wonderful hereditary conservation, which insists on like begetting like, depends upon long associated habits of the cellular protoplasm of the embryo itself; in other words, upon memory processes which would appear to have a very definite physical basis.

There is reason to believe that memory has its place in the structural as well as in the temporary reaction of living organisms. It would be outside the scope of this article to follow the intricacies of embryological processes; albeit the broad principles may be indicated. Our bodies are composed of myriads of units, called cells. But the term is hardly appropriate, seeing that these cells are not hollow receptacles. They are, in the main, filled with protoplasm. True, some grow fibrous, cartilaginous, or even osseous, in order to subserve their particular wants; nevertheless constitutionally they remain definite body-units.

Our body-cells bear some analogy to the bricks of a building. Whence have they been derived? From that wonderful single cell we call the Egg, technically known as the ovum or germ-cell, after a special part of its protoplasm, called the nucleus, has fused with that of a much smaller cell, the spermatozoon or sperm-cell. The egg-cell proceeds from the female parent the sperm-cell from the male parent. After the nucleus of the latter has fused with the nucleus of the egg we hear no more of its individuality. It finishes its career by acting as a fertiliser. Fertilisation awakens the egg into a wonderful state of activity. Carrying with it the combined hereditary factors present in the conjoined nuclei, it starts to divide actively and with great rapidity into daughter-cells, each of which in turn repeats the process, and hands on the stimulus to its descendants.

As a result, myriads of cells, clustered together into a mass resembling a mulberry, are formed. The generic name of the fruit is *Morus*, hence the term *Morula* has been given to this stage of embryonic development. These cells, at first simple, form the raw material, the "bricks and mortar," so to speak, out of which the body is built up. The "bricks" arrange themselves in a wonderful manner to suit the architecture of the "edifice." Not only are walls formed and apartments partitioned off, but also, by a process of infolding and separating certain groups of bricks, the vital organs (already assuming their requisite contour) are laid down. From the embryo, in all cases limbless at first, simple buds sprout forth, which later on become differentiated into characteristic forms As already mentioned, these buds all arise in like manner, whether they afterwards become a flipper of a whale, a hoof of a horse, or a human arm terminating in its free fingers and thumb, which can perform such exquisite, delicate, and skilled movements. Such then are the broad outlines which

EGGS OF BIRD AND REPTILE COMPARED

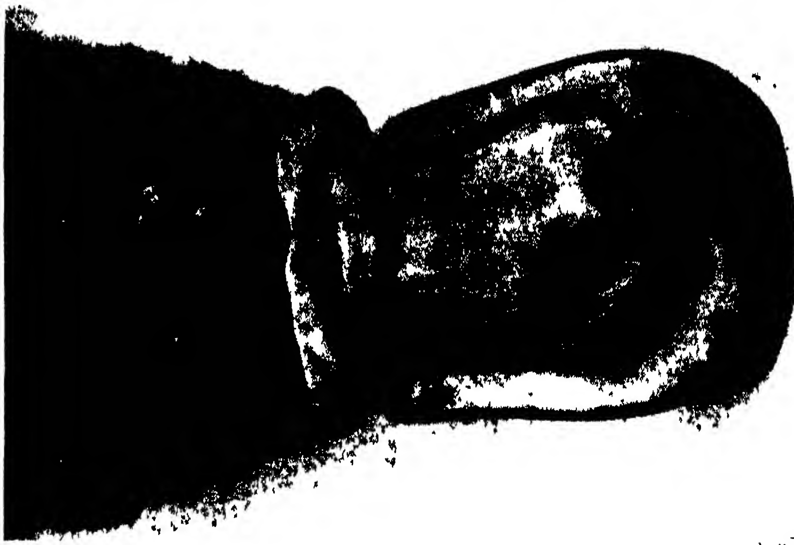
The first egg here is that of a python, the second that of an ordinary barn-door fowl, and the third a crocodile's. In size, shape, and colour there is little difference, but a crocodile's egg placed under a hen might cause her some surprise when hatched out.

Zoological Society, N Y

mark developmental processes in the individual as yet unborn

Whence can we trace the existence of the egg? In those far far away vistas of the past, those almost inconceivably remote ages when naught else of life but the egg existed; when by fission it formed two daughter eggs, each descendant in turn repeating the process, not clustering to form a body; but moving away independently; each a sole reproductive unit; *a physically immortal being!* Cells as they multiplied had not commenced to form tissues, there was no aggregation of "bricks and mortar"; no edifice was erected. In other words no body was appended to the eternal reproductive system, hence no corpse needed casting off. Descendants of this ancestral egg, marvellous to relate, still persist unchanged, while others have proceeded far ahead, growing more and more elaborate, until they acquired bodily organization which has culminated in the development of the stupendously complex vertebrate series

FROM a single-celled microscopic organism, represented by the amoeba which has persisted to the present day (though it no doubt at the first dawn of life existed in a still more simple form), and comparable to the single-celled egg of existing creatures, all multi-cellular organisms have arisen, whose descendants in turn commence life as a single cell, the egg. So the cycle of life goes on, ever evolving from the simple to the complex; ever elaborating; ever adapting



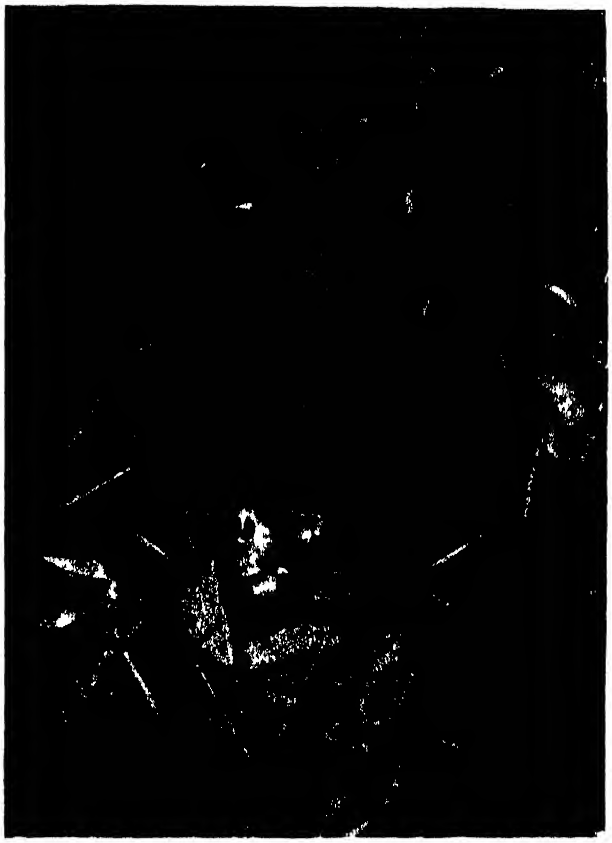
E R Sanborn

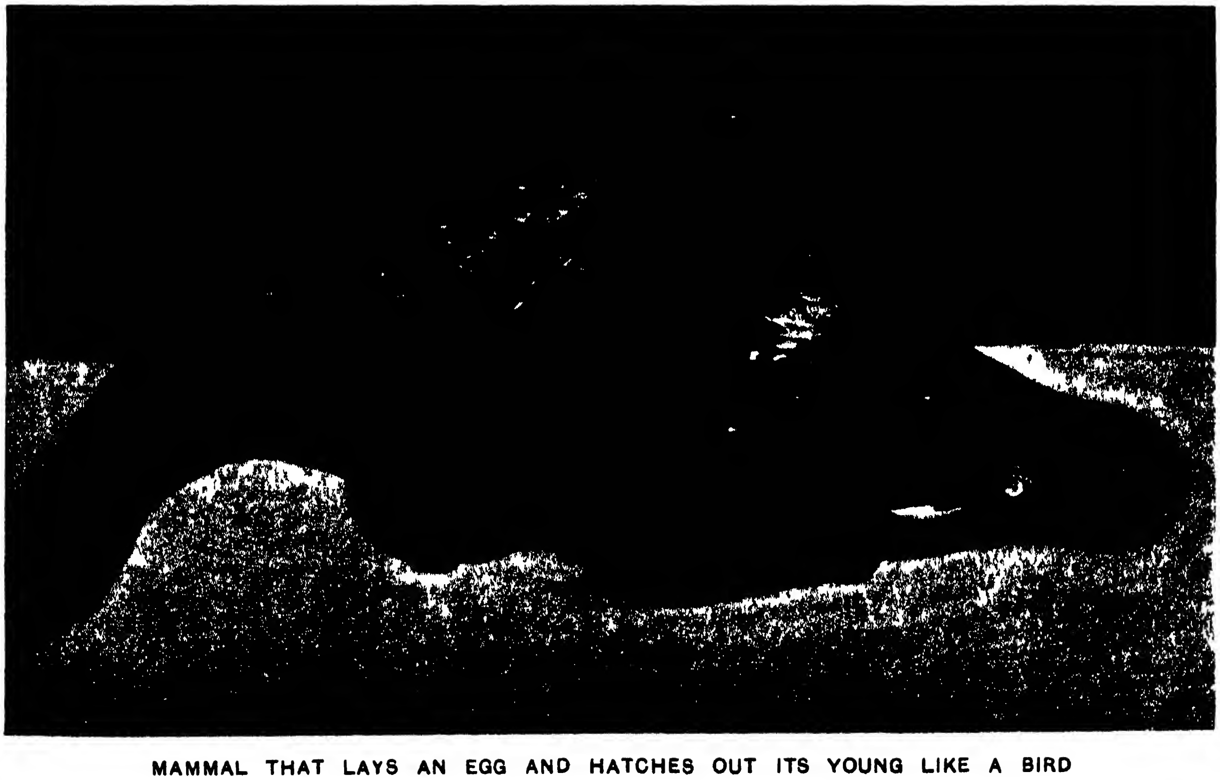
THE STRANGE, BILL-LIKE MOUTH OF THE PLATYPUS

This Australian mammal, with mouth like a flattened beak and webbed feet, seems to have much in common with the duck, and is popularly known as the duck-bill. It lives largely in the water, and finds its food—worms, insects, and small crustaceans—by probing in the mud. It is nearer the reptiles than the birds Above is a side view of the bill and below, a top view

Let us now make a general survey of the characteristic features present in the eggs of various animals according to their position in the Animal Kingdom. Let us follow the way in which these features arose and adapted themselves to the wants of the individuals Beginning with organisms which occupy the highest position in the Zoological Scale, namely, the Mammals, we find that the egg, with very few exceptions, is extremely small

In Man, who we know is a mammal, it is barely visible to the naked eye, reaching only one 125th of an inch in diameter, and destitute of a shell No calcareous or other tough protective encasement is necessary, seeing that this minute germ of life is "laid" within the uterus of the mother. Nay more, not remaining merely on the surface of the cavity which it first touches, it soon embeds itself in the actual substance of the uterine wall. In that way it shuts itself off from all possible dangers which might be caused by shock or injuries to the mother. Here, in its snug little excavation, and surrounded at an extremely early stage by a mantle, which forms a bag filled with fluid (technically called the amnion, and popularly the caul), it sends out thousands of fine branches with tiny blood-vessels, which take up nutriment from the mother's uterine circulation.





MAMMAL THAT LAYS AN EGG AND HATCHES OUT ITS YOUNG LIKE A BIRD

The platypus, or ornithorhyncus as scientists call it, is one of the strangest of living mammals, for its young are produced from eggs which the mother lays in a nest (top left) and sits on as a hen does on hers There may be one, two, or three eggs in the nest, and when hatched (top right) the young are blind. They have little cheek teeth which soon drop out, and each jaw is then furnished with two pairs of horny plates. Full grown (bottom picture) the fur-covered platypus is about eighteen inches long, and it sleeps rolled up like a hedgehog. Its temperature is below that of other mammals. The upper photographs are by Mr Harry Burrell and the lower one by Mr. Elwin R Sanborn

What Comes out of An Egg

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down the gullet by a muscular mechanism in connection with the mammary gland. All living marsupials are indigenous to Australasia, with the exception of a few species of opossums which are found in America.

More aberrant still are the Monotremes, which include the duck-mole, or duck-billed platypus (*Ornithorhynchus*), and the spiny ant-eater (*Echidna*). They lay comparatively large eggs, measuring from half an inch to an inch long, invested with a white shell, tough yet flexible. The platypus excavates long serpentine burrows, with branching recesses

We may compare the embedding of the mammalian egg and its fine rootlets to the germination of a tiny plant which, on sinking in the soil, sends out innumerable fine root-hairs. The caul usually ruptures and the fluid escapes just before birth, though not invariably. David Copperfield came into the world, caul intact. No doubt the sailors in the time of Dickens considered him a lucky infant ! The minute mammalian egg is not heavily laden with yolk ; moreover, the yolk-sac, which afterwards becomes demarcated from the rest of the embryo, shrinks almost to a vanishing point at a very early stage. As a nutritive organ for the embryo it is supplanted by a vascular spongy structure—the placenta—derived in the main from the wall of the mother's uterus. With this the embryo comes into intimate connection through the extremely fine vascular rootlets mentioned above. Such then is the typical way in which the minute egg of the placental mammal becomes connected with the mother. At birth the offspring reaches its full natal development, and gestation often covers a prolonged period

EGGS OF TWO REMARKABLE BIRDS

Birds' eggs are generally laid in nests or in some safe place on the ground, but the tuamoke or fairy tern of America lays its solitary egg on the bough of a tree (top). Below is an ostrich egg and a young one just hatching out. It is fitting that a big bird should come from a big egg and the ostrich's weighs as much as two dozen hen's eggs

IN Marsupials, such as the kangaroo, that is to say animals provided with an abdominal pouch into which the embryo is born prematurely after a short period of gestation, the egg is also small ; but it is provided with a considerable amount of yolk, and the sac remains large, enabling the unborn young to obtain much nourishment from it. The embryo is not intimately attached to the uterus ; only in a small measure its connection with maternal tissues is made by fine rootlets from the yolk sac. The offspring, when born into the pouch, is far too premature to start to suck in the ordinary mammalian manner. Nature provides that when the teat has become engaged in the mouth, the milk is pumped

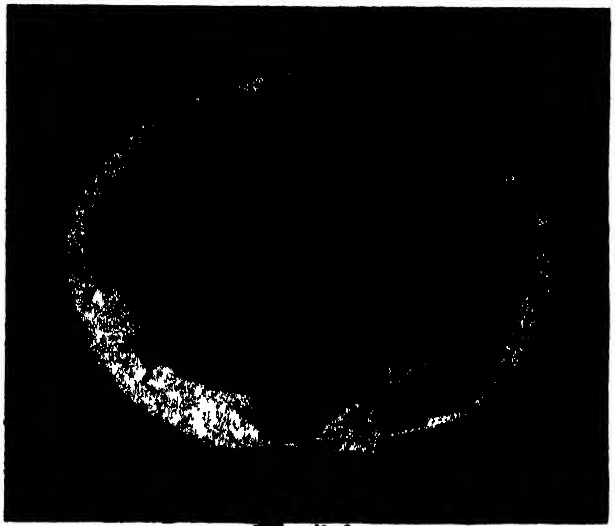
In one of these, well above high-water mark, the eggs are deposited, two forming a clutch. The echidna also burrows, but it would appear that the eggs from the beginning are hatched and carried in a pouch which develops as a temporary measure. Most of us are familiar with the curious form of the platypus, a creature about half a yard in length, clothed in dark brown, short, soft fur, and provided with protruding flattened, horny jaws, which bear a startling resemblance to the beak of a duck. The eyes are very small, and no external ears are visible. The animal is aquatic, living along the banks of lakes and rivers. Its front limbs are webbed and clawed, and it swims and dives with speed and alacrity.

The echidna, or spiny ant-eater, frequents drier and more elevated situations. It may be found in timbered districts, at a height of three thousand feet, provided ants are plentiful. It varies in size according to species, but on an average its dimensions are comparable to those of a large hedgehog. Like the latter, it can roll itself into a ball, its spiny coat protecting it from the enemy. Usually however, it bolts for its burrow when suspicious

After twelve hours

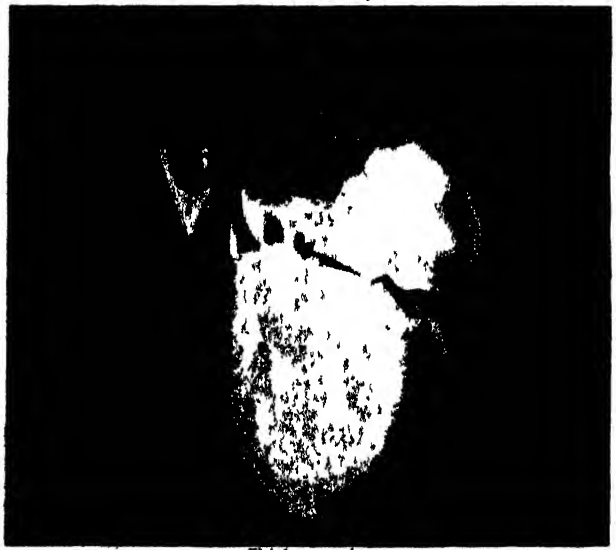
Third day

Eleventh day



Fifteenth day

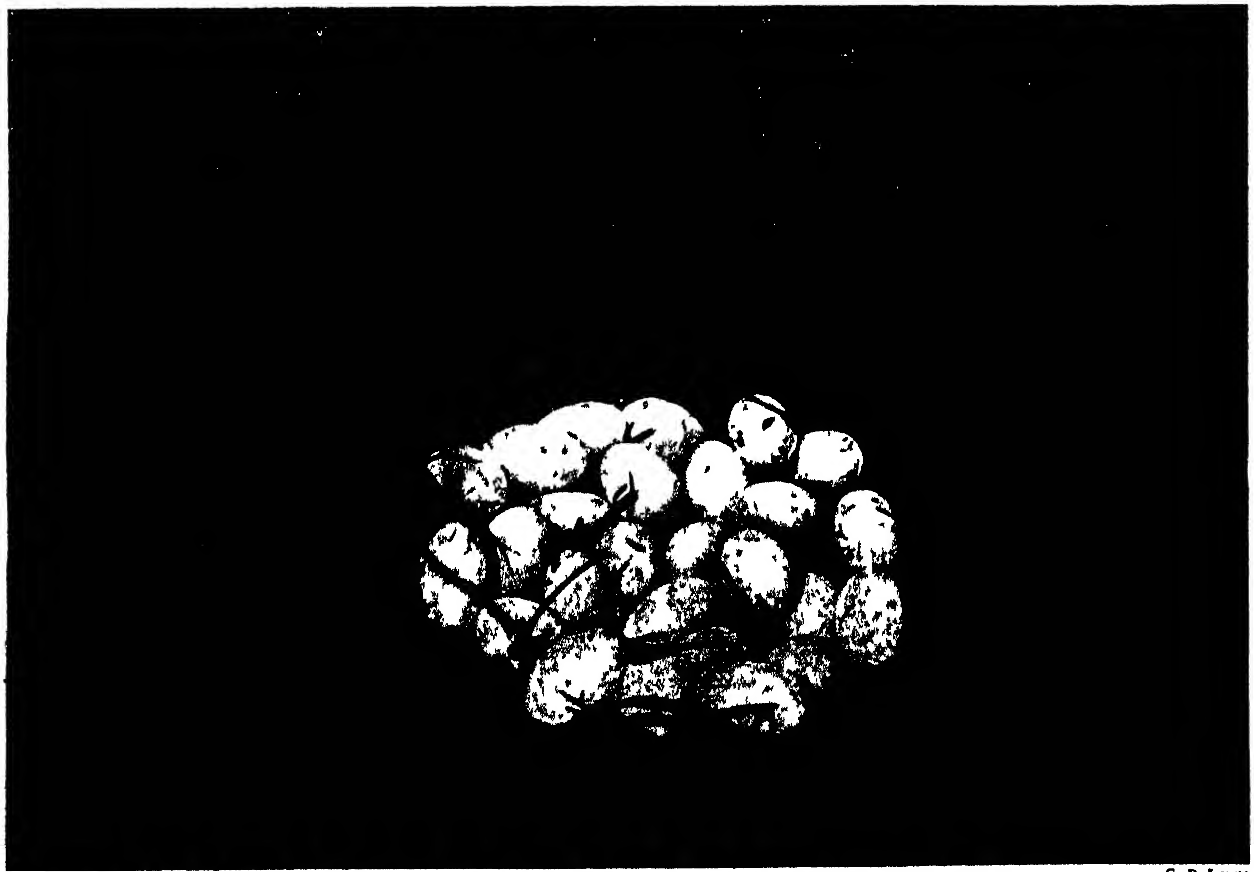
Twentieth day



Chick emerging

THE EGG OF THE DOMESTIC FOWL AND THE CHICKEN THAT COMES OUT OF IT

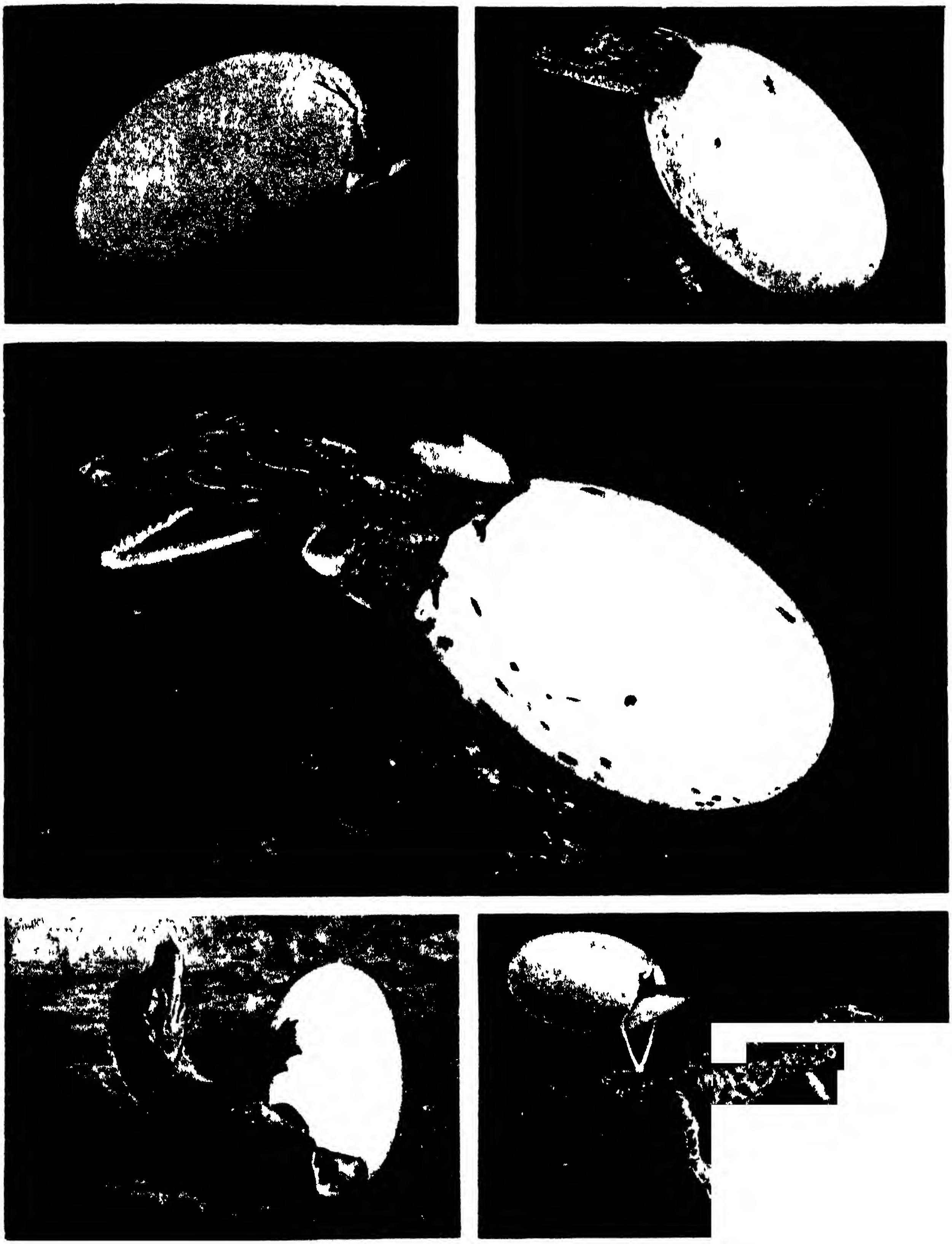
If the fertile egg of a hen be broken open there will be noticed on top of the yellow yolk a small white spot. This represents the germ or protoplasm which will develop into the chick, and the yellow cushion of yolk on which it rests provides a store of food which is gradually absorbed as the bird develops in the shell. It is the germ and yolk which really constitute the egg The albumen, or "white," and the shell are merely accessory structures. These remarkable photographs show six stages in the hatching out of a chicken from the egg



A CROCODILE'S NEST WITH THE MOTHER GUARDING HER EGGS—

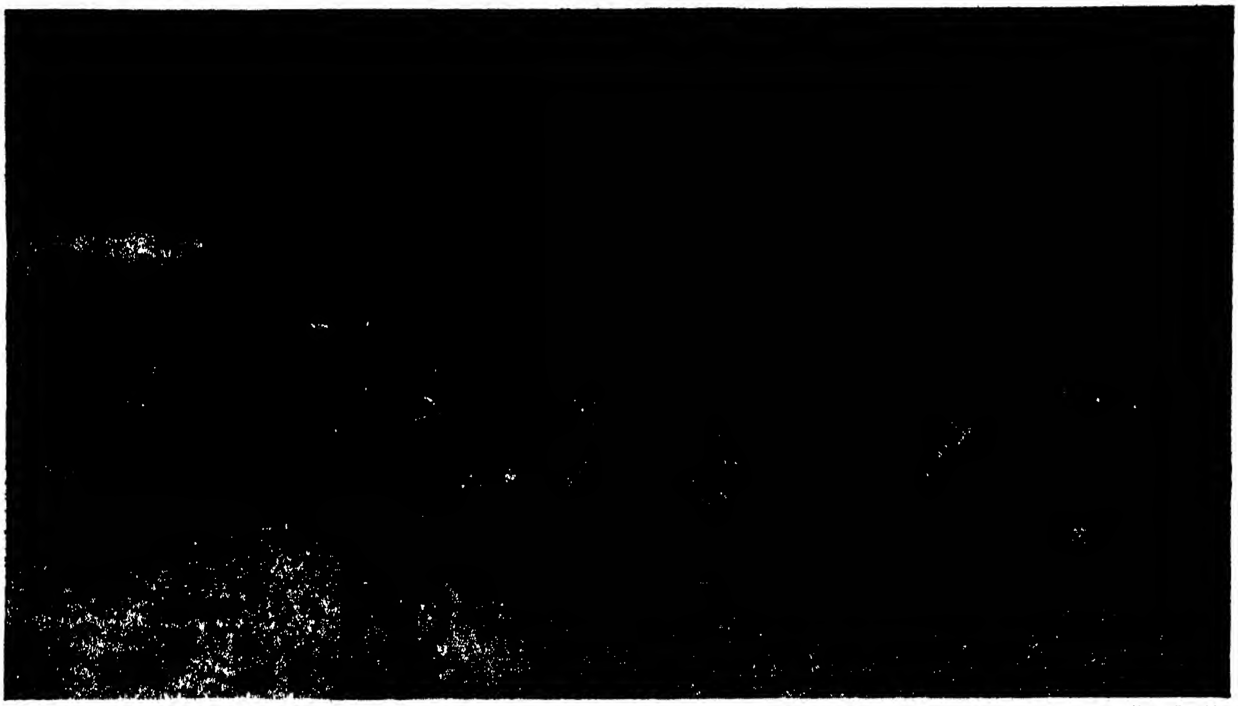
G P Lewis

Crocodiles and alligators, giant reptiles that sometimes grow as long as eighteen feet, are hatched out of eggs with a hard white shell about the size of a goose egg Some crocodiles lay their eggs, ranging from twenty to sixty in number, in a hollow of the sand by the river bank—where they bask, and others, like the marsh crocodiles of the Dutch East Indies, build a nest of leaves, twigs, and branches, as seen in these photographs, and there lay a clutch of eggs (bottom) The mother then retires to a shallow trench surrounding the nest (top) where she guards the eggs from marauding monkeys, and ten weeks later the young reptile hatch out.



—ONE OF THE YOUNG CROCODILES EMERGING FROM THE SHELL

The actual birth of a young crocodile is shown in these remarkable photographs, all of which, except the fourth one, were taken by Mr. Felix Kopstein and are reproduced here by courtesy of " Asia " magazine, New York. When the young reptile is ready to emerge it makes some sound, and if the eggs are buried in the sand the mother crocodile uncovers them. The baby crocodile then cracks the shell and (top left) pokes the tip of its nose out. Then (top right) it pushes the whole of its clumsy head out. Gradually more and more of its body emerges (centre and bottom left) until at last (bottom right) it is clear of the shell. Even while hatching it shows signs of savagery.



W. S. Berridge

ENGLISH GRASS SNAKES COMING OUT OF THEIR EGGS

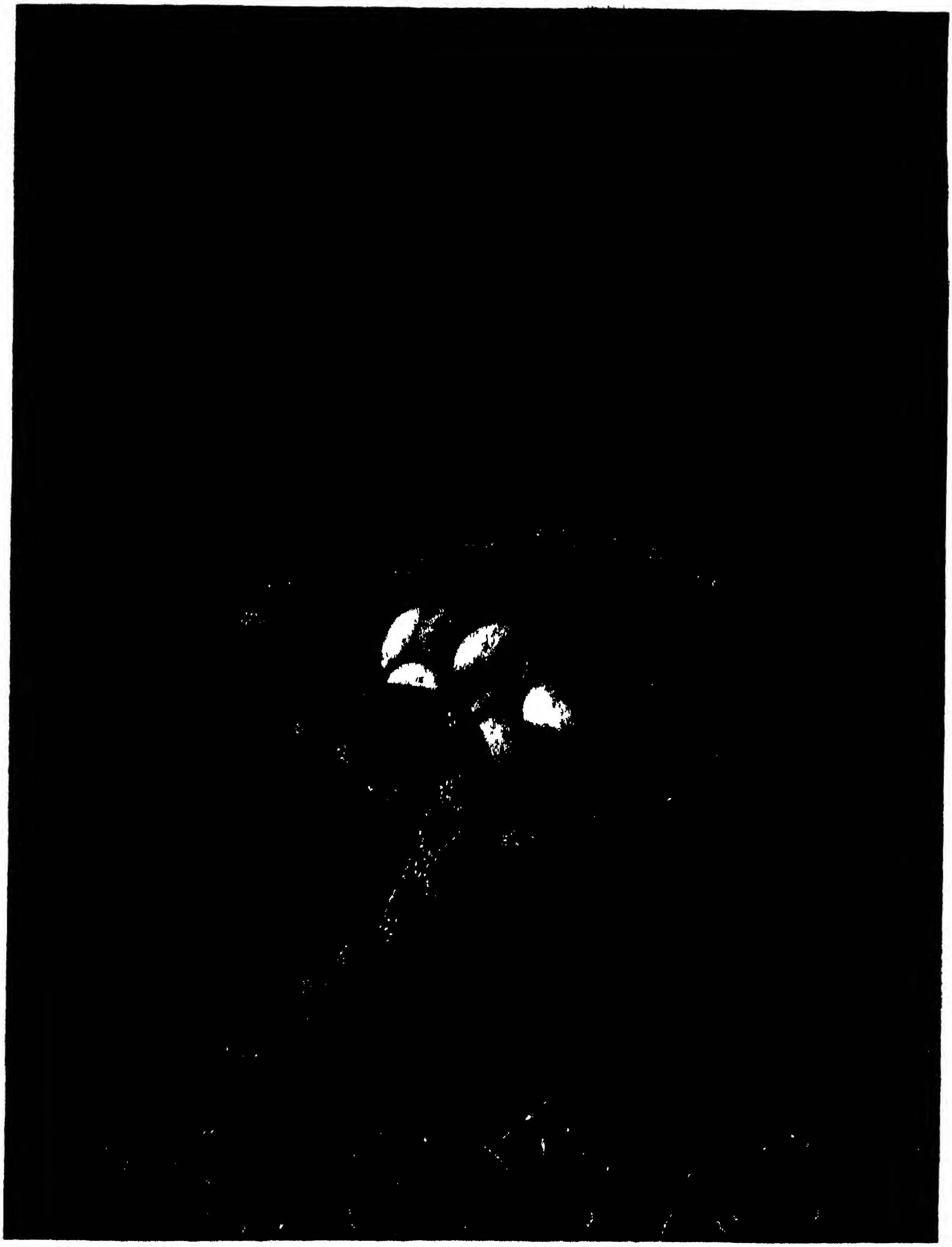
It is curious how frightened most people are when they find a grass snake and still greater is their horror if they come across a cluster of eggs with the young snakes just hatching out, as in this photograph. Yet the grass snake is quite harmless to human beings, does good to the farmers by devouring field mice, and is a very beautiful creature, exceedingly graceful in its movements. It makes an excellent pet, is easy to keep, and soon gets to know its owner. Grass snakes love the water and may often be seen swimming in lakes and brooks.

In both platypus and echidna, the young break loose from the egg-shell at a very imperfect stage of development. The skin is naked, the eyes closed, the beak very short and pliable in texture. The frail little offspring is carried about for a time in a recess of the skin studded with milk-glands, the ducts of which open on the surface without the intervention of teats or nipples. The young seize hold of the skin over a diffused area at the bottom of the transient pouch, and vigorously suck the milk, as a schoolboy in a hurry might deal with a juicy orange! The inception of temporary "brood-pouches" foreshadows the further development of those which have become permanent in the marsupials, thus affording an interesting link in the chain of evolution.

We naturally ask—why do these strange mammals lay large eggs after the fashion of birds and reptiles? Furthermore we ask—will they continue the practice? They lay eggs like birds and reptiles because their reproductive receptacles are built on exactly the same plan. They have no uterus to accommodate a growing embryo; no "soil" in which a minute egg could become embedded. They are provided with only comparatively thin-walled tubes—the oviducts—in which the eggs, in gathering up their yolk and shell, may tarry awhile, but no attachment ensues; the eggs are always on the move towards the exterior. Reaching a common chamber, called the cloaca, which also receives the excretory products, the egg is soon expelled from the body through a common outlet. This structural arrangement is found in reptiles and birds. These creatures we know are typically oviparous, and a shell protects the egg.

But it is fascinating to observe that a similar arrangement maintains also in the embryos of the placental mammals, provided with a uterus. It is an arrangement, however, which has only a passing phase. As development goes further forward, the simple cloacal clamber, with its single exit, is supplanted by the more elaborate arrangement of the external passages and sex-organ chambers, which is typical of the great Order of Mammals. It is obvious, then, that platypus and echidna will continue to lay eggs invested with a shell, as long as their sexual receptacles correspond structurally to those of birds and reptiles.

The duck-mole and spiny ant-eater have a limited geographical distribution. They are not found outside Australasia. In that respect they resemble in distribution the Marsupials which, with the exception of the American Opossums, are confined to Australia and Tasmania. All these animals belong to a very low Order, animals which have survived without further development, owing to insulation of their native soil before alien competitors could manage to invade them. Australia geographically thus became a sanctuary for her indigenous mammals. They were not forced to part with their primitive characteristics though in habits of life they specialised in all



HARMLESS AMERICAN SNAKE WHICH INCUBATES ITS EGGS

Although most snakes leave their eggs unattended to be hatched out by the heat of the sun or of the manure in which they are laid, there are some that incubate the eggs themselves, curling round them and assisting with the heat of their bodies. The python is a notable example of this rare maternal instinct, and another example is the pine or bull snake of America, shown in the photograph. This reptile is creamy white, blotched with brown, and it often grows to a length of six feet It is pugnacious and malodorous, but not poisonous

F. W. Bond

TOAD AND CRAB CARRYING THEIR EGGS

The midwife toad in the upper photograph is a male, and when his mate lays her eggs threaded together by elastic filaments and gelatinous capsules the male attaches himself to them and carries them with him till they are hatched. The crab (below) is a female, the underside being shown with a mass of eggs attached to her body These she takes about with her.

directions. Domestic tragedy in a large measure then became Nature's key-note ; carnivorous marsupials preying upon herbivorous marsupials ; Tasmanian wolves and devils dining off kangaroo and wallaby chops and steaks !

Every one knows that birds lay eggs. In some species the ground-colour of the shell is rendered very beautiful by delicate tints, enriched further by spots, streaks, and blotches of darker hue. The pattern of the markings is usually distinctive. In many cases the ground-colour remains an unspotted monochrome. The shell is, in all cases, composed of carbonate of lime, and is hard, though brittle. The comparative size of egg to bird is a very inconstant equation indeed. But even in the case of those birds which lay relatively small eggs (for instance, the cuckoo) the egg remains gigantic when compared with that of the typical mammal. Generally speaking, the independent, precociously-developed chick, which races hither and thither directly it is hatched, emanates from a large egg. This is particularly the case in birds whose clutches are small and hence capable of being covered by the sitting parent. The eggs of the mallee-fowl and brush turkeys are enormous proportionately to the size of the parent. The young are born fully feathered, and can fly almost immediately.

These birds are known as mound-builders, because they lay their eggs on substantial hillocks composed of sandy soil containing decomposing vegetable matter. The heat dissipated becomes sufficient to incubate the eggs. The parents display the reptilian habit of not brooding on their eggs : the young chicks have never known their parents. They must shift for themselves immediately they come into the world. Hence their unusually precocious development. What a striking contrast the infant pigeon presents : scarce able to lift its head, it requires the assistance of its parent who, engaging the little beak within its own, pumps softened regurgitated food down its throat.

The immense size of the bird's egg depends primarily upon the enormous aggregation of yolk, a necessary provision for the sustenance of the fast-

BIRTH OF A CROCODILE PHOTOGRAPHED EMERGING FROM THE EGG

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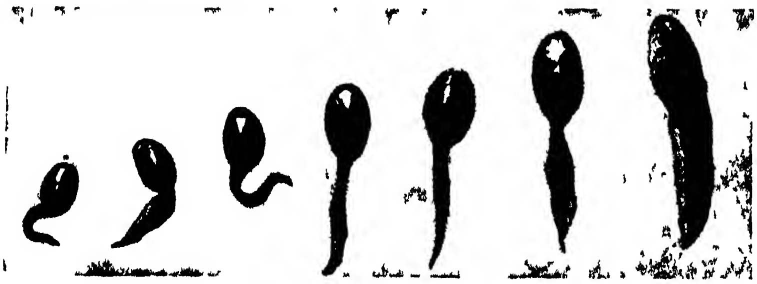
F W Bond

HOW THE YOUNG TORTOISE IS BORN AND THE MOTHER GUARDS HER EGGS

Tortoises like crocodiles lay eggs, but these vary much in size and shape Most of them like those of the grooved or spurred tortoise of these photographs are spherical, and in the case of the giant species of Galapagos the eggs are as big as tennis balls Those of the water terrapin are elliptical. The grooved tortoise is a native of the hot regions of Africa and the shell is often three feet long, measured across the curve As the bottom photograph shows, the young at the moment of birth is a small replica of its parents

The spawn or egg cluster

Tadpoles forming in the egg



Stages of tadpole growth

The legs begin to form

Tail disappears and legs become perfect

THE FROG FROM EGG TO PERFECT AMPHIBIAN

The frog lays a number of eggs at the bottom of a pool or ditch and these, by absorbing water swell and rise to the surface, where they float as a gelatinous mass. After a time the tadpoles hatch out, and these grow rapidly, developing gills and a big tail, which later is absorbed. Then lungs and legs form, and the perfect frog comes to land The photographs are by John Roberts and M H Crawford

growing embryo during incubation Birds are highly specialised creatures, but it is interesting to note that their specialisation bears a stamp of uniformity The fore-limbs are highly specialised to subserve the function of flight, yet we cannot point to one single instance in which either these or the hind-limbs are wanting: nor can we point to any bird being viviparous. It is different with Mammals Whales, porpoises, and dolphins, have lost their hind-limbs; and viviparity gives way to oviparity in the duck-mole and also in the spiny ant-eater.

LIKEWISE in the Reptiles, specialisation has not proceeded on uniform lines. The snake has departed still further from type in becoming quite limbless, and also in a minority of instances in being viviparous A few species of lizards also are hatched before they leave the body of the mother. But reptiles, like birds, are typically egg-laying creatures As in the case of birds, the eggs of reptiles are large and heavily laden with yolk. The shells, however, unlike those of the birds' eggs, can lay no claim to beauty. In those of snakes they are oblong in shape and leathery in consistency. In crocodiles and alligators, and most other classes of reptiles, they are calcareous. In some species, notably the common land tortoise (a familiar garden pet) the shell is so dense that it becomes quite a business to pierce it with a steel egg-drill.

Speaking generally, the eggs of reptiles are nearly circular in shape; unglazed in texture; and dull whitish in colour. They are laid in great numbers: a clutch ranging from fifty to two hundred. The eggs are usually deposited in hollows excavated for their reception. They are carefully covered up with the soil, and hatched by the heat of the sun's rays. It is easy to understand why so large a clutch is permissible. Reptiles do not brood; if they did and the eggs depended upon the heat derived from the area of the body which could cover them, the clutches, like those of the bird, might be composed of only about half-a-dozen eggs!

Here, however, we note an extremely interesting exception The python, having carefully stacked her eggs so as to form a convenient pile.

coils herself round them and, with maternal solicitude, broods over her numerous treasures for three whole months! Her length and girth reach such remarkable dimensions that she can gather in her coils actually her entire progeny! But a brooding tortoise or turtle could never cover her clutch. It should be noted, however, that the eggs of reptiles are generally proportionately smaller than those of birds. The egg of the crocodile, for instance, is comparable in size to that of the goose; the egg of the green turtle (a creature three feet long) to that of the domestic fowl.

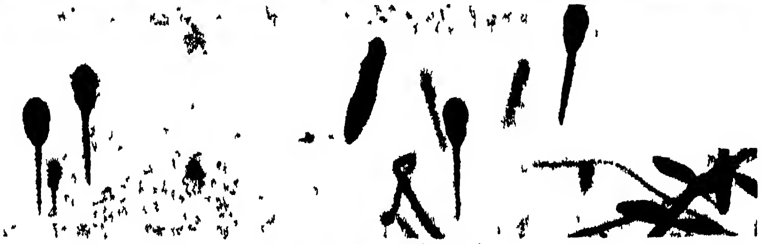
Infant reptiles have to shift for themselves at a tender age. Mothers may defend the newly hatched (which at times include other than those of her clutch) against the onslaughts of a hungry adversary. Parental care, however, soon comes to an end as the youngsters begin to wander from her side and fend for themselves.

BELOW the Order of Mammals, vertebrate animals are typically oviparous. We have seen that no exceptions arise among the birds. Below that order, exceptions do occur among the reptiles, as in a few snakes and lizards; among the amphibians, as in the salamanders; and among the fishes, as in some sharks. It is difficult to account for these anomalies. Curiously enough, it is in the typical condition that instability may arise. Thus it has been observed that the oviparous grass-snake, and a few other non-poisonous species, may be induced in confinement, and under other unusual conditions of life, to become viviparous.

It would appear that the converse has not come under observation. Eggs of the viviparous British adder or of the rattle-snake of America have not been observed aggregated for purposes of incubation. In the vast domain of Invertebrates oviparity, or egg-laying, is the rule. We find only a few forms of insects are viviparous. But we are confronted with so many strange forms which issue forth from the egg, forms strikingly dissimilar to their parents, and forms which portray such a complicated embryonic life-history, that even a general survey of the eggs and progeny of invertebrate creatures in general, would take us too far afield.

The chain of eggs

Tadpoles hatching out



Tadpoles rising to the surface

Young toad ready to land

The full grown toad

THE LIFE STORY OF THE COMMON TOAD

The toad, when fully developed, is much more terrestrial in habit than the frog. Its eggs, however, like the frog's, are deposited in water, not in clusters, but in long double chains, and when hatched out into dark-coloured tadpoles, the creature's life, in its early stages, is very much like the frog's. It is slower in movement than its relation. The photographs are by W. S. Berridge and M. H Crawford

What Comes out of An Egg

F. W. Bond

HUGE SNAIL WITH ITS EGG AS BIG AS A PIGEON'S

The Brazilian giant snail, the largest of its kind, has a shell that often reaches a length of six inches, and it lays an egg about the size of that of a pigeon or ringdove. When the time of hatching comes the egg-shell breaks and a young snail emerges which is a miniature of its mother Giant snails are found not only in South America and the West Indies, but also in South Africa.

We shall conclude by confining our attention to some salient points in regard to the eggs of insects and the behaviour of the progeny when hatched. It seems appropriate to say a few words about the eggs of insects, seeing that in form and structure they fall somewhat into line with the eggs of oviparous vertebrates in being rendered definitely opaque because they are encased in a firm, resisting shell.

On an average, insects' eggs measure in length a few millimetres. They differ from the eggs of oviparous vertebrates in their immense variety in form and shape. Even among the butterflies and moths alone we recognise oval, circular, barrel-shaped, and flask-shaped, forms, with their surfaces smoothed, embossed, pitted, ribbed, and reticulated.

Some insects deposit their eggs singly or in small groups; this method is adopted by the house-fly. Others lay them in great numbers which are clustered together. The blue-bottle fly offers a familiar example. They are usually deposited on substances which provide food for the hatched offspring, and they are held together by adhesive material during the period of incubation, which is a matter often of but a few hours. Sometimes, however, the eggs, if laid in the autumn, behave like seeds in not "germinating" until the warm days come in the following spring.

What comes out of the egg is commonly called, in the insect world, a larva. We hardly think the expression appropriate when the young is an exact miniature replica of its parent. True, wings are suppressed until adult life; but we know that there are insects which are wingless throughout their existence. It is among such forms that the newly-hatched egg may bring forth an absolute facsimile of its parent. Notable examples are the lice and springtails. Newly hatched earwigs, cockroaches, and locusts have no wings; otherwise they resemble the adults. In mayflies and dragonflies there is a distinct difference between the aquatic and wingless larvae and the aerial adults, provided with beautiful lace-patterned wings. Nevertheless, the metamorphosis here is only partial.

In butterflies, moths, beetles, ants, bees, and several others, we have a very different story. The larvae are not only quite different in form from the adults, but they also differ markedly in habits of life. These larvae feed greedily, grow rapidly, moult their epidermis frequently, soon become motionless, and encase themselves within a firm chitinous shell or silken cocoon. The chrysalis or pupa stage is now reached in which the larval organs are wholly disintegrated. From the "debris" new "bricks and mortar" are manufactured which are utilised in building up the various organs, and so on, of the adult. The latter in due time sallies forth, an active winged-insect called the imago, leaving the empty husk behind. It should be noted that the caterpillar represents the typical and fully-developed larval form with the limbs and head developed. Grubs have a head but no limbs; "maggots" are destitute of both. Larvae vary enormously in size, shape, and other particulars.

Many forms are exceedingly destructive, greedily devouring the living tissues of both vegetables and animals. Happily, in the Economy of Nature they have many enemies. Nevertheless, by means of strategy, of mimicry, and of protective coloration insect larvae manage to hold their own so tenaciously that at times they invoke the wrath of the agriculturist, fruit-grower, farmer and cattle-breeder. The wholesale raids made, on such provocation, by human agency are warmly supported by the community

Chapter XI

Solving the Secrets of Animal Life

The Naturalist and His Fascinating Task

By Prof. J. Arthur Thomson

Regius Professor of Natural History, Aberdeen University; Author of "The Study of Animal Life"

SOMETIMES we wonder far too much, oftener far too little. After a fine lecture on the Wonders of Astronomy, a member of the entranced audience was heard to remark that he thought the greatest wonder of all was that these men of science had been able to find out, not merely the distance and composition of the stars, but their actual names. That was pseudo-wonder. One also remembers the dear old lady who remarked that what seemed to her to be a very admirable wonder of the world was the way in which so many great rivers ran through great towns. That was another pseudo-wonder.

On the other hand, we often wonder too little, for we take scientific achievements for granted, and get no glimpse of the often consummate patience and ingenious device by which steps of importance have been made. Here I wish to give some illustrations of this from the field of Natural History.

At a very low estimate there are 25,000 named and known backboned animals, and ten times as many backboneless animals; and there is some reason for pride that they have been arranged in approximate order so as to show their relationships. We can usefully, but woodenly, arrange our books according to their sizes, or alphabetically according to their authors' names; but it is not this wooden kind of classification that has been worked out for the tens of thousands of different kinds of animals and plants. What may be called "blood-relations" are grouped together, and in many cases it is possible to draw a tentative genealogical tree. How has this been done?

More than two thousand years ago, Aristotle (384–322 B.C.), with his discerning brain, saw clearly that living creatures must be grouped according to their deep resemblances of structure. Unlike some of his successors, he knew that whales must be placed among mammals, not among fishes; and similarly that bats were flying mammals, not birds. He knew that the resemblance between a whale and a shark was quite superficial. Both are suited for cleaving the water, but a whale has a mammal's brain and skull, heart and lungs. No whale is quite without hair, and the mother gives milk to her young.

STRANGE SEA HORSE

From the strange resemblance of the head and neck to that of a horse this quaint relative of the Pipe fish gets its name. It moves in a vertical posture by the vibration of its solitary fin.

Classifying must be grounded upon deep resemblances of structure, taking the young stages into account, if possible. Everyone is familiar in the summer months with swallows, martins, and swifts. After looking carefully a few times, one says to oneself: "There is no confusing these three birds, though they fly about after insects in somewhat similar ways. The swallow, for instance, is marked by its continuously blue back, by chestnut and blue bands on its breast in front of the white, and by its long forked tail. The house-martin has a shorter tail, and it has a white rump splash as well as continuous white underneath. The swift is dusky all over and has much longer wings." This is good enough for a beginning, but a more important step is made if we are able to examine, let us say, the skulls and the toes of the three birds. For then it becomes plain that swallow and martin are "perching birds," or Passerines, and first cousins, while the swift belongs to a different group altogether, and is nearer the humming-birds.

ARISTOTLE'S resolute clearness of mind enabled him to discern that superficial likenesses are apt to be misleading; a true classification, that brings real relations together, must dig deep. The shape of an animal counts for little and the colour for nothing in classification; it is necessary to get down to the architecture of important parts like the skull and the backbone, the brain and the heart. The same resolute clearness of mind was displayed when Huxley showed that reptiles and amphibians should not be held as near allies, though a lizard is often superficially like a newt, and though a limbless reptile, such as a slow-worm or blind-worm, is superficially like a limbless amphibian—a Caecilian also confusingly known as blind-worm.

Huxley peered into deep resemblances, and showed that backboned animals fall into three great groups First, the Ichthyopsida, namely, Fishes and Amphibians, second, the Sauropsida, namely, Reptiles and Birds; and third, the Mammals by themselves. Cuvier, who was a very great anatomist, had not freed himself from the old idea that amphibians

and reptiles were near one another. Huxley had insight and courage enough to say: "no, in spite of appearances, amphibians are nearer to the fishes, and reptiles are nearer to the birds."

One of the warnings that the history of science gives us is the story of the Dark Ages. The foundations of science were laid in a magnificent way in Greece three or four centuries B.C. When we name Hippocrates, Eudoxus, Aristotle, and Archimedes, we are selecting four very great men out of a brilliant aristocracy of intellect. They had their successors, but gradually the tradition became dim, and the end of progress, on the Natural History line, was with the genius of Galen. He was one of the greatest of biologists, who died about 200 A.D., obliged to flee from his practice in Rome because of the fierce jealousy of his fellow physicians, whose wilful ignorance was made uncomfortable in face of the science that Galen had built up by looking for himself at the structure of the human body.

But after 200 A.D. the darkness set in, and for twelve centuries or more, with no doubt a few luminous exceptions, the night lasted. Aristotle's biological works had not been translated into Latin, which was very unfortunate; but men were preoccupied with the practical tasks of war and peace, they were under the spell of tradition and authority, and somehow they had lost the desire to make new knowledge for themselves. It is an extraordinary fact that Galen found no successor until another foundation-layer, Vesalius, published in 1543 his "Structure of the Human Body," in the same year as the revolutionising work of Copernicus, "On the Revolutions of the Heavenly Bodies."

The darkness of the Middle Ages was not only retardation, it was relapse. Having ceased to look for themselves and face the facts, having apparently lost the desire to know in the Aristotelian and modern sense, men fell into the quagmire of magic and floundered after the will-o'-the-wisps of wild fancy. Although Galen had made great steps in elucidating the structure of the human body, men took it upon themselves to portray what they thought the interior of their bodies should be. And, similarly, in regard to the realm of animals, fabulous creatures acquired credit beside the familiar beasts of the fields; popular names, like sea-horse for a fish and sea-mouse for a worm, were taken literally, to the damage of sound classification. The moral is that degeneration follows the loss of the desire to know for oneself. The danger is not by any means absent to-day. The making of new knowledge is the test of scientific health; but how is the new knowledge reached? Take a few examples from Natural History. The great majority of the European eels spawn in a stretch of water towards the Bermudas in the North Atlantic, as described

M. H. Crawford & W. S. Berridge

SWIFT, SAND MARTIN AND SWALLOW OFTEN CONFUSED

When we see twenty or thirty birds swooping and wheeling fifty feet up in the air, all hard at work catching flies, we are apt to say "swallows" and leave it at that. But, at a distance, swifts and sand martins are easily confused with swallows. The swift is not related to the other two and all three differ in size, colouring or structure.

S. C. Johnson

F. W. Bond

SLOW-WORMS—SO CALLED

The slow-worm (top) is also known as the blind-worm. But its movements are by no means slow, it is not blind, and neither is it a worm. So much for the name. Further, the creature looks like a snake but is really a lizard. Below is a real snake, an adder.

in another chapter. How did Johann Schmidt find this out? By some seventeen years of patient observing. It was known that eels never spawn in fresh water; it was known that young eels, or elvers, come up European rivers from the sea, and that there is no return journey until the eels are five to eight years old. Then it was suspected that strange creatures of the open seas, like transparent knife-blades, that had been named Leptocephali, were the young stages of eels, long antecedent to the elvers. What Schmidt did was to collect, on a fishery investigation vessel, all the sizes and gradations of these Leptocephali, or glass-eels, till he had a complete series from very young creatures, not longer than half the breadth of one's little finger-nail, on to larvae the length of one's middle finger, and thence to elvers, with reduction of length to one's first finger, and with change of shape from penknife blade to slender knitting-needle form.

Then, year after year, with Darwin-like patience, he tow-netted in the Atlantic, carefully recorded where the glass-eels were common and where they were rare, and where they were large and where they were small, till he was able to map out their spawning waters and write their diary from the still unknown hatching of the eggs to the eel-fare of the elvers up the rivers, which they ascend when about two and a half to two and three-quarters years of age.

In the Dark Ages people repeated to one another many extraordinary stories about the life-histories and transformations of animals. Thus there was the story of the barnacle tree that grows by the sea-shore, whose fruit "if it falleth on land dieth, but if it falleth into the water it liveth, and becomes the familiar barnacle goose." The real story of ship barnacles is not less wonderful, and it has this great superiority—that it can be verified by anyone with good eyes and plenty of time. Yet the first discovering of the life-history is often a triumph of insight and patience. Let us take the story of Bilharzia, a peculiar little worm belonging to the class of flukes which is a painful parasite of man in some warm countries, such as Egypt. The bilharzias live in couples in the blood-vessels of the bowel and bladder, the half-inch male carrying the inch-long female. Each of the many microscopic eggs has a sharp spine which cuts into the walls of the blood-vessels and causes serious trouble, as well as severe pain. In some places every third child is infected with bilharzia, a very dreadful handicapping of life.

Now many naturalists had tried to clear up the life-story of this formidable little worm, and some useful facts had been established. But it was not till the War that the whole story was made clear, and largely by the thoroughness and resoluteness

Hiskins

EARTHWORMS, MAN'S GREATEST BENEFACTORS

It was left for one of the greatest scientists, Charles Darwin, to discover the true worth of the earthworm. All his life he accumulated facts about it, and finally reached the conclusion that there are about 53,000 worms in an average English acre, and that every year some ten tons of soil per acre are passed through their food canals thus enriching the soil.

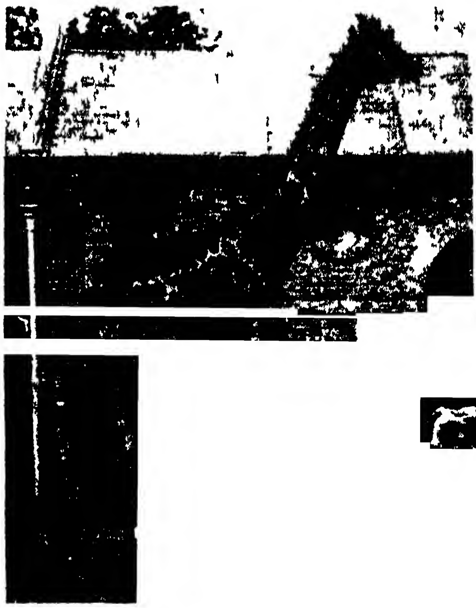
Elephant

Camel

Horse

Hippopotamus

Llama



Giraffe

Hyrax

Pig

Sheep

WIDELY DIFFERING RELATIONS ALL OF THE SAME GREAT FAMILY—

In previous pages we have seen examples of creatures which resembled each other superficially but were really separated by important differences Here we have a group of animals whose appearance is, in each case, definitely distinctive and yet which are really related It is the work of the scientist, equipped with knowledge and inspired by genius, to find truth amid what at first appears to be the bewilderment of Nature Step by step, clear thinking and undeviating diligence have brought to mankind the marvellous truths of the animal world

Rhinoceros

Deer

Buffalo

Ass

Tapir

Antelope

Ox

Zebra

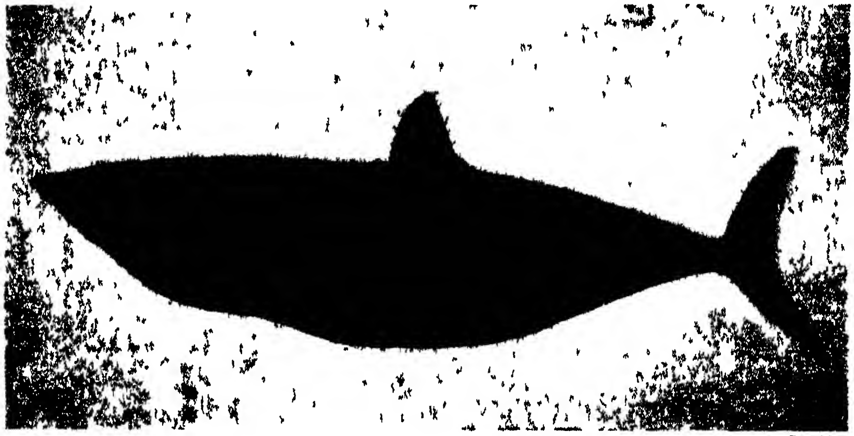
—THE UNGULATES WHICH ARE MAMMALS EQUIPPED WITH HOOFS

Who would have thought to find a close relationship between the Rhinoceros and the Zebra or the Llama and the Pig before the naturalist solved the problems which creation has set? The family of the Ungulates, or hoofed mammals, includes every animal present in this and the opposite page The little hyrax, which looks something like a rabbit, is actually a development of the Ungulates, and related to the elephant Thus have varying conditions and ages of time worked upon this amazingly varied stock of some remote common ancestor

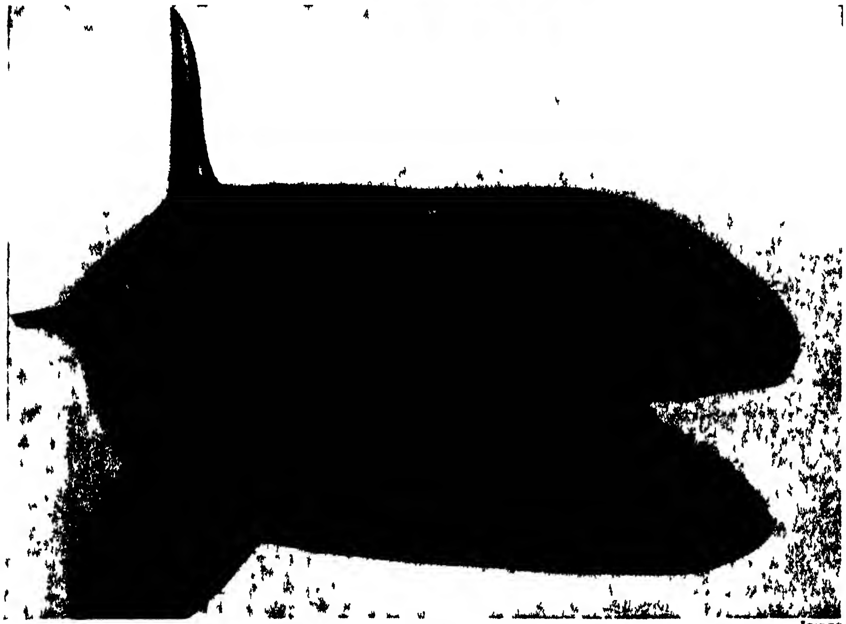
of one observer, Major Leiper, who remembered to great advantage what he had learned as a medical student in Glasgow University regarding the life-history of the common liver-fluke of sheep. It was this that gave him the clue which he followed.

If the microscopic eggs pass from man into pools of water they hatch into free-swimming larvae which find their way into water-snails, such as Planorbis. There they multiply and produce a second kind of larva with a bifid, or forked, tail. These, called Cercariae, leave the snail, swim in the water, and bore their way into the skin of children paddling in the pool, or of washerwomen busy with the clothes, or of gardeners watering the flowers with a hose, or of soldiers bathing out of bounds. In some places, as in Japan, the second host is not always man, but it may be a cow standing in the water; in some cases man is infected not through the skin of hands and feet, but by his mouth, as when he eats raw vegetables that have been soaked in contaminated water.

Now Major Leiper not only discovered the larvae in the water-snails and the free-swimming stages in the water, he also showed that the Cercariae die if the water is kept drawn for thirty-six hours, or if a little sulphate of soda is added when the lettuce or the like is washed. Thus, by his scientific thoroughness, he saved many lives.



W. S. Berridge



James

FISH AND MAMMAL THAT RESEMBLE EACH OTHER

If animals were classified by the unscientific according to their apparent resemblances most people would certainly place these two creatures in the same family. Both live in the sea, and their outward forms are much alike. But one (above) is a fish, the mackerel shark, and the other (below) is a mammal, the killer whale. Scientists are able to place them in their correct classes.

Darwin was in the habit of saying: "It's dogged that does it." But that is true only of certain ways of making new knowledge. Thus, like Gilbert White before him, Darwin had the conviction that earthworms are the most useful animals in the world, because they have made and continue to make the fertile soil. He proceeded to prove this doggedly, and from his student days in Edinburgh, when he was trying to be a medical, on until he was an old man, he continued accumulating facts in regard to the agricultural work of earthworms. His book, "The Formation of Vegetable Mould through the Agency of Earthworms," was on the stocks for over forty years, and was not published till 1881, the year before his death. Patiently and by many measurements, Darwin showed that there are 53,000 worms in an average acre of English soil, that they pass ten tons of soil per acre per annum through their food-canals, that they bury the surface with their castings at the rate of three inches in fifteen years, and so on. With sublime doggedness he proved that earthworms have been the great soil-makers.

But discovery often means much more than doggedness; it implies a flash of insight that is afterwards put to the proof, or the use of some new method or instrument, such as statistics or the microscope, or the application of a new idea, like Darwin's idea of Nature's sifting.

Let me give a few instances. Bacteria, the extremely minute organisms (well called microbes, which means small life) which cause rotting and disease, but many changes that are beneficial, were first seen by the Dutch observer Leeuwenhoek towards the end of the seventeenth

century, but a recognition of their importance is to the credit of Pasteur, who died in 1895. It was in a natural and logical way that he came to realise the many-sided rôle that bacteria play in the world by putrefying, fermenting, poisoning and digesting, but he reached his conclusions by insight long before he had patiently proved them. What a step it was in theory and in practice when Pasteur showed that many diseases, the causes of which had been entirely obscure, are due to the operations of minute living creatures. All over the world Pasteur's central idea made the visible intelligible in terms of the invisible

John J. Ward F.E.S.

SEA MOUSE THAT HAS NOTHING TO DO WITH MICE

From some rather imaginative resemblance to a common household pest this marine worm has been called sea mouse by popular fancy. The worm is between three and five inches long and has an oval body. Its back is covered in broad plates and its underside with feet and bristles. Specimens are sometimes washed ashore round British coasts

Sometimes the new step has been the outcome of a certain resoluteness of mind, the discoverer saying to himself. "How can I prove this so that no one can doubt?" And the method of proof has often been nothing more than shrewd commonsense. Thus for a long time naturalists had discussed with one another how much of an animal's behaviour should be called instinctive and how much should be called intelligent, the point being that instincts are ready-made, inborn powers of doing apparently clever things, whereas intelligence means individual learning and judgment, putting two and two together, and controlling behaviour in the light of previous experience; which also means the use of memory.

One may argue about this for a long time and not get any further, but a definite step was taken when Lloyd Morgan and others began making the simple experiment of hatching birds' eggs in an incubator and seeing what the young creatures were able to do in isolation from their kind. If chicks incubated in the laboratory pay no heed to their unseen mother's cluck outside the door, this proves, for chicks at least, that a recognition of the mother's call is not instinctive. But if, in similar conditions, a newly-hatched peewit utters the characteristic call-note, this proves the instinctive nature of the peewit's simple effort at speech.

For a long time it has been known that if a hive-bee finds a nectar-treasure, such as a fine patch of white clover, she fills her honey-sac and makes a bee-line for home. But in a short time there is a little band of bees exploring and exploiting the honey patch. How does the news spread? To this it was customary to answer that the first discoverer, having unloaded her treasure-trove in the comb, proceeds to guide her sisters to the clover-patch. But by the simple device of marking individual bees, and by the neat arrangement of having an observatory hive with windows through which one can peer, Professor K. von Frisch was soon able to prove that the old answer was wrong, and that something quite different actually happens. The bee that makes the discovery is in no hurry; she is quite well-pleased with herself. She does not show her sisters the way; indeed, they find the treasure before she comes out again.

What happens is that the well-pleased bee executes a little, but very characteristic, "nectar-dance" on the honeycomb, and when she is seen dancing the bystander worker-bees, who have been resting near, come nosing about her, and get the scent of the clover, or whatever it was, from her body. With this as a clue, they hurry off on the search for flowers with that perfume. The bee-language is partly a dance and partly a fragrance. Von Frisch's story is more detailed and convincing than we can indicate here, but the point is that by resoluteness of method he was able to pass from what had previously been mere vague hearsay to verifiable science.

Till a century ago the naturalist's knowledge of the migration of birds was very general and vague, but gradually the standard of bird-observing was raised. Precise records of arrivals and departures began to be kept, and thousands of facts were gathered from lighthouses and lightships, and other strategic stations. This was all very well, but a distinctive step was taken when the "ringing method" began to be widely used. That is to say, light aluminium rings with a stamped address were placed on the feet of young birds just before they set off on their autumnal migration to the South.

A variable percentage of these ringed birds was caught elsewhere—in France, perhaps, or South Africa—and if the capturer sent the ring, with due

information, to the stamped address, it became possible to say: This stork, ringed at Dantzig on such and such a date, was captured at Lake Chad, in Africa, three weeks later. As these data accumulated and were registered on a map for each kind of bird, it began to be possible to make definite statements in regard to the paths that birds follow on their migratory journeys. Thus, too, it became possible to prove beyond all doubt that birds sometimes return from distant winter quarters to the place of their birth. A swift ringed in Ayrshire in 1914 was caught again at the same place, with the ring on its foot, in 1918. The bird in question had doubtless wintered in Africa four times between its 1914 ringing and its 1918 "homing."

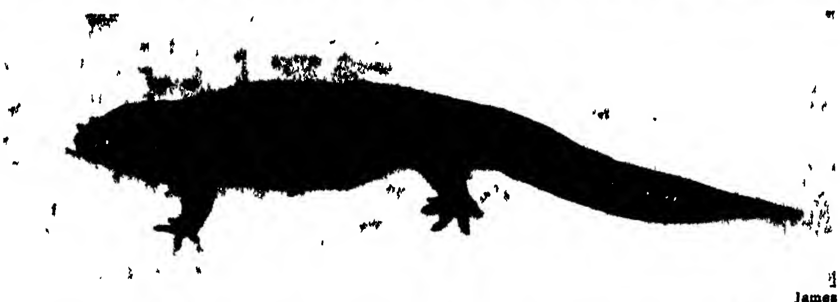
One of the characteristics of the new natural history, as compared with the old, is the more frequent backing of observation by experiment. In the subterranean waters of Dalmatia and Carinthia there lives an interesting newt called Proteus. It is about six inches long, with no visible eyes, and with no pigment except where the red blood shines through the three pairs of external gills. It has been known for a long time in the darkness of its native haunts, a strange, wan, blind troglodyte. Now naturalists discussed with one another whether Proteus has lost the power of producing pigment in its skin, or whether the pigment-forming is simply hindered by the darkness of the caves. Dissection would show that there is a small eye beneath the skin, but one might ask whether the eye suffered from some intrinsic weakness, or whether the arrest of development was due to the absence of light. The discussion might continue for a long time without leading to any certain result; the only way out is to experiment. When the Proteus is brought into a well-lighted laboratory it soon begins to get spotty, and after a while it becomes dark-coloured, like many a newt. This proves that it is the absence of light that hinders the development of the pigment. The power is by no means lost.

Similarly, if the young stages of Proteus are reared in a laboratory under red light, the eye begins again to develop, increases in size, reaches the surface, and becomes a seeing eye. The blind newt receives its sight. The reason for using red light is simply that ordinary illumination causes a darkening of the skin, which would shut off the light before the re-awakened eye had had enough. This clear-cut case may serve to illustrate the value of the appeal to experiment. We no longer suppose that Proteus has lost the sense of sight; we *know* that it has not.

People are sometimes sceptical about the statements naturalists make in regard to numbers. There is a British starfish, Luidia by name, which produces 200 million eggs, but who has counted them? We have so many millions of red blood corpuscles in our blood that their surface area is about 3,300 square yards; but how is that known? In the rind of our fore-brain we have 9,200 million nerve-cells which form the home of some of our mental processes. That is to say, if the population of the globe is 1,750 millions, we have more than five times as many nerve-cells in our cerebral cortex. But how do we know? The answer is, by sampling. In the case of the blood, for instance, we take a small quantity, such as a cubic millimetre (a lineal millimetre is about one-twenty-fifth of an inch so that a cubic millimetre is about one 16,400th of a cubic inch); we easily discover how many drops there are in this small quantity. Then we put a single drop under the microscope and count the number of corpuscles. We do this several times till we have got a reliable average; then we can say that there are five million red blood corpuscles in a cubic millimetre and twenty-five trillion in an average human being.

This "blood-counting" might seem at first sight a waste of time, and yet it may be actually life-saving; for it may enable the physician to detect the first hints of some disease. At every corner we find that science begins with measurement; at every corner we find that science stands for the ending of ignorance and its many evils, and the maintenance and amelioration of Life.

M H Crawford



James

TWO CREATURES THAT LOOK ALIKE BUT ARE NOT RELATED

A lizard and a newt to a casual observer have very much the same form and might well be taken for first cousins. Men of science, however, know that they are not nearly related, for the lizard (above) is a reptile, and as such has kinship with the birds, while the newt (below) is an amphibian and is related to the fishes. Formerly even science was deceived and linked them together.

Chapter XII

Birds That Cannot Fly

By J. R. Ainsworth-Davis

Formerly Professor of Zoology, University of Wales

It is now universally admitted that the innumerable kinds or species of animals which exist at the present time, and the myriads of forms which once existed but are now extinct, were not specially created to suit their surroundings, but have arisen by a process of evolution from earlier types. Birds, for example, are a specialised branch of the reptilian stock, as proved by the " record of the rocks," and the most ancient bird known, archaeopteryx, which is Greek for "ancient bird" actually possessed teeth and a long jointed tail like that of a lizard. But it was an undoubted bird, with wings and feathers, and able to fly somewhat clumsily.

Improvements gradually took place, and an average modern bird, such as a pigeon or swallow, embodies an almost perfect solution of the problem of flight. Some of the wing-bones are firmly fused together, giving effective support to quill feathers that beat upon the air, and the tail has shortened, its end-joints uniting into a ploughshare bone for the attachment of a fan-like group of steering quills. The teeth have disappeared, though traces of them may still be found deeply imbedded in the jaws of a few forms, such as parrots. These are never "cut," and are simply reptilian vestiges, or souvenirs of ages ago.

A typical bird then is a wonderfully constructed flying machine, and yet we all know that some birds, such as the ostrich and penguin, are unable to fly. They possess wings but cannot fly with them. How is this to be explained? They have descended from birds that *could* fly, so the power of flight must have been given up, and the wings have become reduced in size.

In trying to account for the existence of flightless birds we must remember that animals are continually engaged in the search for food, and the vast majority of them are exposed to the attacks of carnivorous enemies, whose pressing attentions can only be evaded by active or passive defence, fighting power or swift retreat. Furthermore the surroundings or environment of an animal are continually changing, so that forms unable to adapt themselves to fresh conditions are liable to become extinct sooner or later.

The acquisition of powers of flight by birds had reference to both these primary necessities. It allowed escape from carnivorous foes only able to progress on the ground, and also rendered it possible to pursue the numerous flying insects which, long ages previously, had achieved the conquest of the air.

But animals always get their living in the easiest possible way, and in some parts of the world, under certain conditions, a number of birds have found it a practical policy to abandon flight, and resume a life on the ground or else become aquatic. It must not, of course, be supposed that such a change of habit was consciously adopted, as it might be in the case of human beings. One very interesting extinct bird, Hesperornis, which lived at a time when the chalk was accumulating as a limy mud at the bottom of the sea, may be taken as a first example. It possessed small pointed teeth and was between three and four feet high, but the wings were mere vestiges and quite useless for flight. Professor O. Marsh described this bird as "a carnivorous swimming ostrich," but later authorities consider it was remotely related to our modern divers. In any case it was entirely adapted to a fish diet.

There can be no doubt that hesperornis was a descendant of flying forms, but in

Autotype

RHEA OF SOUTH AMERICA

Although the Rhea cannot fly its wings are far from useless since, when alarmed, it spreads them and runs with the wind behind it, thus converting them into sails. Its very long legs give the bird great speed and its colour makes it very difficult to see at a distance

the remote times when it flourished predaceous mammals had not come into existence, and the chief enemies to be feared were reptiles, which were no match for the more active and quicker-witted birds. The evolution of the latter involved not only the development of wings but a great improvement in the organs of circulation, the heart being divided into four chambers, thus enabling the impure and pure blood to be kept separate. This led to birds becoming one of the dominant races of animals, for it made them hot blooded, with better nourished bodies, and endowed them with the restless activity familiar to us in modern species. Such creatures would naturally explore the various ways of getting a living, and it is not surprising that some of them took to a fishing life, and became adapted to swimming, with the ultimate result that they became flightless, their wings being converted into paddles.

By the close of the chalk period hosts of reptilian types died out, including carnivorous forms that infested the seas, which were thus rendered safer for adventurous birds, while the rise of predaceous mammals at the same time made the land more unsafe. Many birds that became fishermen retained the power of flight, such as divers, gulls, and albatrosses, but some few abandoned it.

Among such flightless birds the great auk or garefowl (*Alca impennis*) once swarmed round the shores of Iceland, Scandinavia, the British Isles, and Newfoundland, but was exterminated last century by the agency of man, who has been responsible for the extinction of so many interesting forms. It was a large bird belonging to the family Alcidae, which includes the existing razor-bills, guillemots, and puffins, with small wings useless for flying, but serving as moderately efficient paddles for the pursuit of the fish which formed its food.

The last two living specimens were caught at Eldey Island, off Iceland, in 1844, while the latest known captures from other localities were Ireland 1834, St. Kilda 1821, and Orkney 1813. Great auks abounded most in the seas of Newfoundland and, speaking of the islands where they congregated, Professor Alfred Newton says: "English and French mariners alike resorted to these spots, driving the helpless and hapless birds on sails or planks into a boat, 'as many as shall lade her,' and salting them for provision." This ignorance and lack of foresight combined to deprive that part of the world of both an interesting bird and a source of emergency food supply.

Penguins (*Spheniscidae*) are remarkable among flightless birds as expert swimmers of the first rank, their wings serving as highly efficient paddles which enable them to dart through the water in arrow-like fashion, the legs being directed backward in line with the body. The feathers on the wings are scale-like, and quills are entirely absent. On land the body is kept vertical, and they present a comic resemblance to little old men afflicted with corns, waddling along in a somewhat deliberate way, though at feeding time the pace can be accelerated considerably. There are many species, varying considerably in size, the largest being about three and a half feet high.

Penguins are limited to the southern hemisphere, and are particularly numerous in Antarctic seas, where they have few enemies—except man. They range up the Pacific as far as the Galapagos Islands, are to be found on the south coast of Australia and the south and east coasts of New Zealand, round the Falkland Islands, and as far north in the South Atlantic as Tristan da Cunha. They also occur on the coasts of South Africa and some of the lonely islands in the Indian Ocean.

New Zealand is particularly rich in species, and it is not unlikely that penguins first came into existence in that Dominion, where an extinct fossil form nearly seven feet in height has been discovered. If so, they gradually spread from that original home until the existing very wide distribution was attained. In this connection it is important to realize that the relative position of land and sea areas has undergone many profound alterations during the vast period of time for which our planet has existed.

At an immensely remote epoch the East Indies, New Guinea, Australia, New Zealand, and the now intervening seas, formed a continuous land surface projecting from the continent of Asia. By a gradual sinking of the land this area was broken up into islands, and New Zealand was the first to be isolated, Australia the second. The various orders of mammals were meanwhile coming into existence in the main landmass of the Old World, and migrating in all directions until held up by sea barriers. New Zealand became isolated before any of them could get there, and Australia was severed from the main land-mass after receiving a certain proportion of some of the more primitive mammalian forms.

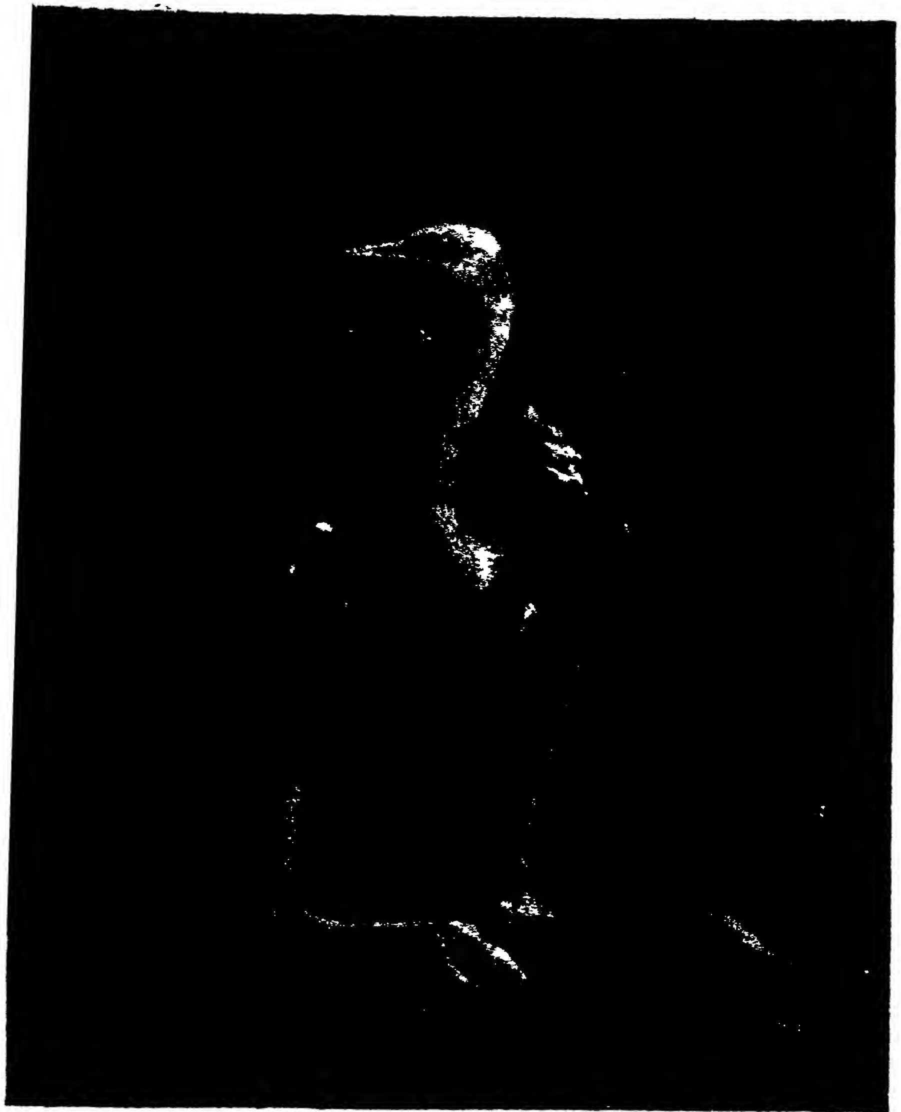
The ocean barriers which prevented the immigration of mammals other than bats into New Zealand and checked that immigration into Australia after the ancestors of the egg-laying types (duckbilled platypus and spiny ant-eater) and pouched forms (kangaroos, wombats, and so on) had gained a footing there, were crossed by a considerable number of flying birds. Some of these, in the absence of powerful enemies, found flying no longer a necessity, and in course of time became flightless. That this really happened is rendered probable by the fact that birds which cannot fly are particularly numerous in both New Zealand and Australia. Penguins have been mentioned already, but before considering the other flightless birds of the Antipodes, the influence of isolation and absence of predaceous enemies will be illustrated by reference to another part of the world where this isolation reached an ideal state.

Réunion, Mauritius, and Rodriguez, are volcanic islands in the Indian Ocean, respectively 320, 500 and 844 miles from the east coast of Madagascar, and devoid of any native ground mammals. Mauritius was formerly the home of a well-known flightless bird, the dodo (*Didus ineptus*), immortalised by the

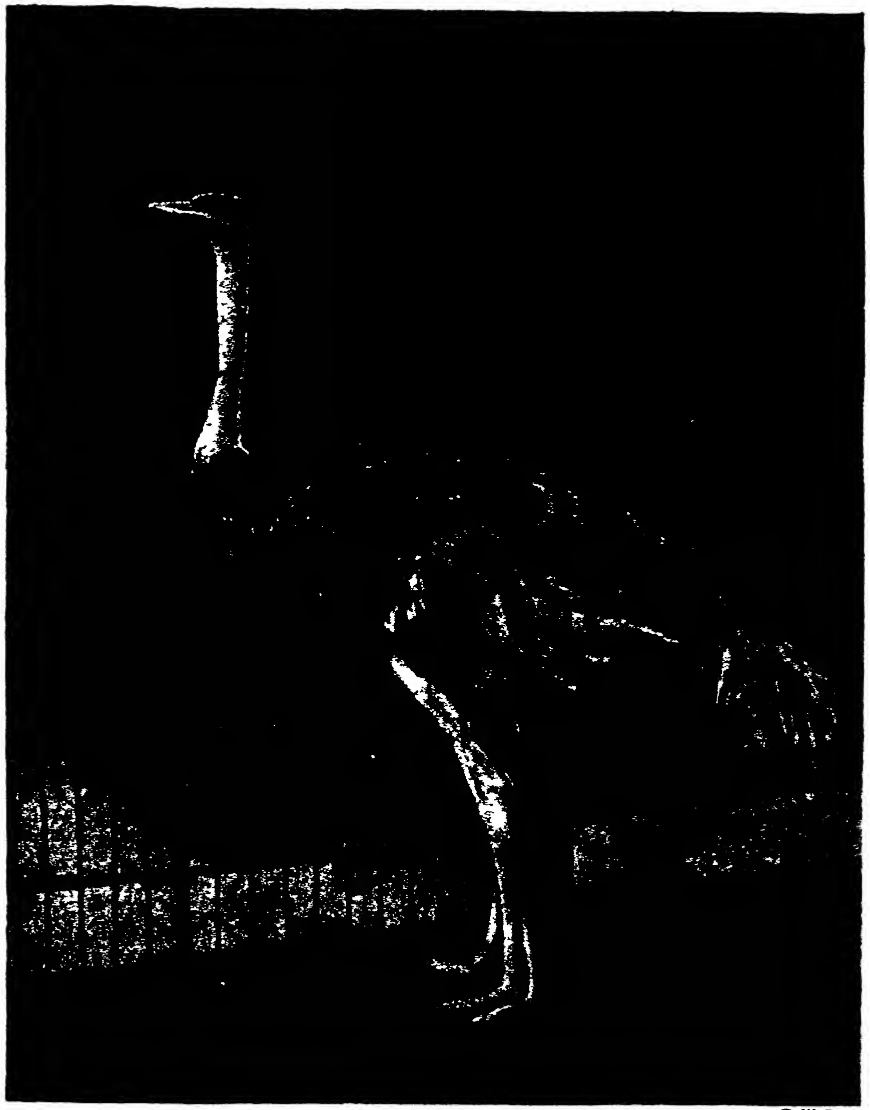
Neville Kingston

PENGUINS WHOSE WINGS HAVE LEARNT TO DO THE WORK OF FINS

Only in the southern hemisphere will you find the penguin in its wild state, and the chief home of this quaint-looking bird is the Antarctic. One of the many strange things about this bird is that its offspring often grows nearly as big as itself before being able to feed without parental help (lower photograph). The King penguin (top left) is the largest of the species, and the remaining photograph shows a Zoo penguin gazing in a worried way at the hole through which his swimming pool has been drained away because of frosty weather.



Neville Kingston



F. W. Bond

POWERFUL LEGS OF THE FLIGHTLESS OSTRICH IN ITS STANDING AND SITTING POSTURES

For the lack of flight the ostrich has compensated itself and thus survived by developing a very powerful pair of legs upon which it is said to run faster than any horse. The feet are more specialised than those of any other running bird, the toes having been reduced in number to two, the third and fourth, with their undersides equipped with pads rather like those of the camel. The bird defends itself with a tremendous side-kick, which is very formidable. The breast-bone is strikingly different from that found in flying birds, which possess a keel to which the wing muscles are attached. Such a keel can be seen when carving game or poultry. But the ostrich has no keel to its breast-bone. The plumage, too, is markedly different in that the feathers are not interlocked.

expression "as extinct as a dodo," and Belloc's description in the "Bad Child's Book of Beasts":

The Dodo used to walk around
And take the sun and air,
The Sun yet warms his native ground—
The Dodo is not there!
The voice that used to squawk and squeak
Is now for ever dumb—
Yet may you see his bones and beak
All in the Mu-se-um.

It was a clumsy creature, larger than a turkey, and distantly related to the pigeons, which had a large blackish hooked beak, and an apology for a tail in the form of a curly tuft. It was endowed with a goose-like voice, and laid a single large white egg. First observed by the Dutch in 1598 it had become extinct by 1681, as a result of the introduction of pigs, cats, and dogs, to say nothing of its ruthless slaughter by human beings. The ancestors of this unfortunate bird found plenty of food in the forests, and became flightless, while in the absence of enemies they did not acquire the power of rapid locomotion on the ground, or other means of effective defence. It may also be mentioned that flight may be actually dangerous to the inhabitants of islands where strong winds are prevalent, so that the assumption of a ground habit avoids the danger of being blown out to sea and so perishing.

Another species of dodo (*Didus borboni*) once lived in Réunion, but this also was exterminated in similar fashion. The same fate befell a related form, the solitaire (*Pezophaps solitarius*) of Rodriguez, a flightless bird somewhat larger than a swan.

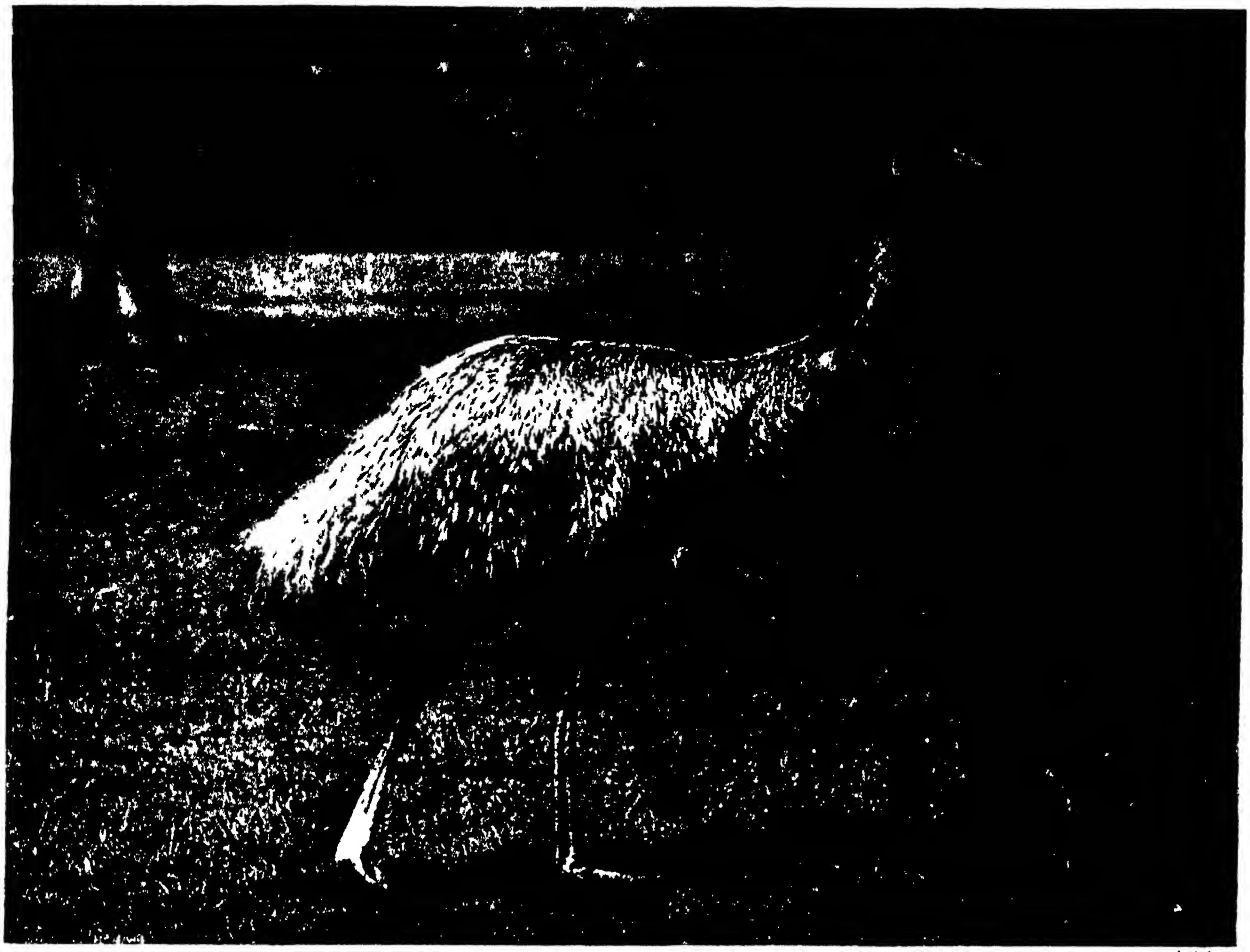
New Zealand, to which we will now return, is notable for the number of flightless ground birds, extinct or still living, which have made it their home. Among them are species of the cosmopolitan family of rails (*Rallidae*) which include our own corn-crake and moor-hen. Though most members of the family can fly it is noteworthy that they spend much of their time on the ground or, in the case of moor-hens, in the water. It may be mentioned, in passing, that flightless cousins of the latter are found in the islands of Tristan da Cunha, Gough, and Gilolo.

In ground-rails the body is flattened from side to side, which facilitates rapid progression through close-growing vegetation, and baffles pursuit by predaceous mammals or birds of prey. New Zealand's extinct forms include a gigantic flightless rail, the Aptornis, of which near relatives inhabited Mauritius and Chatham Island in comparatively recent times. A smaller bird of the kind, the takahe (*Notornis*), also unable to fly, one of the world's rarest birds, was last recorded in 1898, but is possibly still in existence. The weka rails or wood hens (*Ocydromus*), small

Autotype

CURIOUSLY CRESTED CASSOWARY, HANDSOMEST OF RUNNING BIRDS

Despite the well-known rhymes about the missionary and the cassowary that lived "on the plains of Timbuctoo," this bird is not found at all in Africa, but is a native of New Guinea. The cassowary is the most handsome of the running birds, the neck and head, bare of feathers being very brightly coloured. The wings are small and the plumage hairy in appearance



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GRACEFUL EMU OF THE AUSTRALIAN PLAINS

Two species of Emu, a bird confined in Australia and some of the neighbouring islands, are found, the one in the east and the other the west of the continent. The birds live on the plain, or in the more open wooded country, and are able to run very fast. Like the ostrich, to which they are next in size of the running birds, they defend themselves with powerful kicks, but backwards as well as sideways. The wings are entirely useless, and the neck and head are covered in feathers. A full-grown bird stands over five feet high.

brown flightless birds, are represented by three or four living species.

The kakapo or owl parrot (*Stringops*) is another existing New Zealand type devoid of powers of flight, and among extinct forms in similar case were a kind of goose (*Cnemiornis*); a gigantic bird of prey (*Harpagornis*); and the moas (*Dinornithidae*), representatives of the running birds which will now have to receive our consideration.

RUNNING or ostrich-like birds make up a somewhat miscellaneous assemblage of flightless forms characteristic of the southern hemisphere, though true ostriches range north of the equator. In all of them the wings are either very small or practically absent, and the breast-bone is a curved plate devoid of the laterally flattened projection or keel to which the muscles of the wings are attached in ordinary flying birds. Anyone who has carved a fowl must have noticed this keel when cutting slices from the breast, really the muscles of flight. The shape of the breast-bone has suggested a somewhat fanciful resemblance to a raft or flat-bottomed boat, for which the Latin name is *ratis*. Hence the scientific name *Ratitae* has been coined for this group, as opposed to the term *Carinatae*, which is given to the flying birds with reference to the presence of a keel, the Latin for which is *carina*. But it should be noted that in such forms as the flightless rails and owl parrot of New Zealand the breast-bone has also lost its keel, or nearly so, but this does not indicate relationship to ostriches, being simply an adaptation to habit.

The running birds have soft or even hair-like plumage, and any quill feathers that may be present differ in structure from those of a flying bird in one very important particular. Examination of such a feather taken from, say, a pigeon will show a central axis bearing flattened branches or barbs, provided in their turn with branchlets or barbules that interlock by means of minute hooks. The combination of strength and lightness thus secured adapts the feather to its function of rowing or steering in the air. There is no such interlocking in the quills of running birds, where the barbules are disunited, as may be seen in

the elegant ornamental plumes of the ostrich. In an ordinary flying bird, again, some of the end-joints of the short tail are fused into a ploughshare bone for the support of a fan-like group of tail quills used in steering the flight. There is no need for such an arrangement in running birds, and the end-joints of the tail remain distinct, with rare exceptions.

Running birds are divided into the following six divisions, which will be considered successively: first, moas; second, kiwis; third, cassowaries and emus; four, rocs; five, American ostriches or nandus; six, African ostriches.

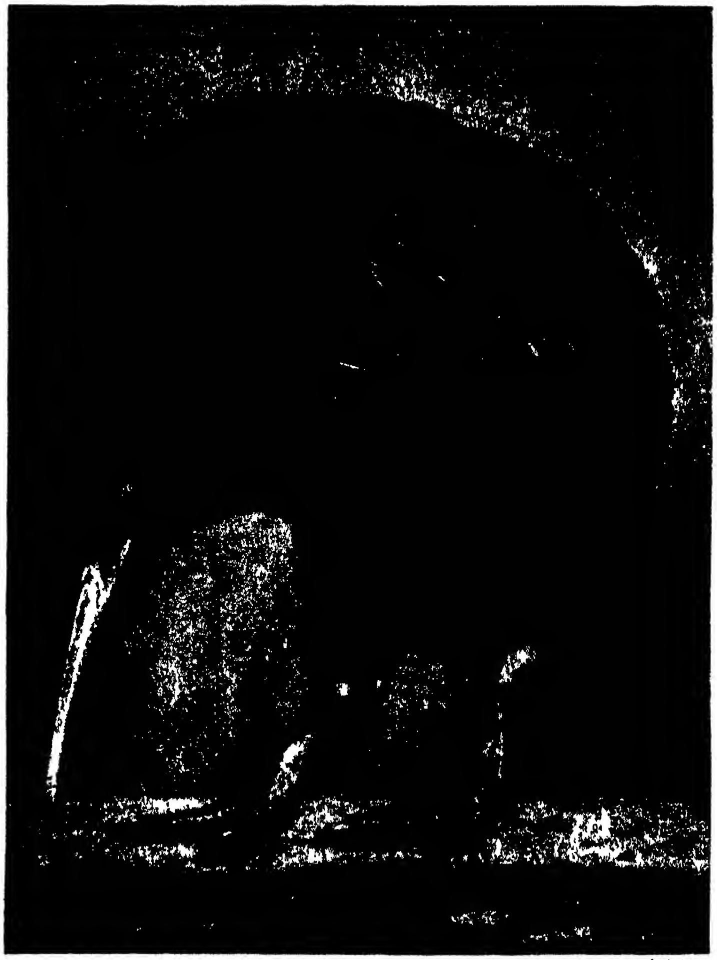
MOAS (*Dinornithidae*) include about twenty species of remarkable extinct birds which formerly abounded in New Zealand, and were finally exterminated by the Maoris three or four hundred years ago. Native traditions credit them with having been somewhat slow and clumsy. They had mere vestiges of wings or none at all. There were three spreading toes, directed forwards, and in some cases a small great toe directed backwards. Some species were no larger than a turkey, while others were gigantic, attaining a maximum height of over ten feet, as against the eight feet of an African ostrich. In the remote past, before human beings made their way to New Zealand, that country passed through a period during which the climate was rigorous, and in all probability this ice age brought about the extinction of most of the moas, the remainder being doomed to extermination at the hands of man. Not only bones, but eggs, feathers (resembling those of emus), and mummified remains have been found.

Kiwis (*Apterygidae*), of which several species exist in New Zealand, are four-toed birds with greatly reduced wings and tail, hidden in the hair-like plumage. The nostrils are in an unusual position, being close to the tip of the long slightly curved bill, thus helping them to detect the presence of the earthworms which constitute their food. They live in wooded country, are nocturnal in habit, and are able to run very rapidly when alarmed. Their cry is a sort of whistle, to which the native name of kiwi has reference. The egg, about five inches long and three broad, is enormous considering the size of the bird, which is no bigger than a hen belonging to one of the heavy breeds.

Cassowaries (*Casuariidae*) and emus (*Dromaeidae*) are long-necked three-toed running birds with greatly reduced wings and no obvious tail. The plumage is of hairy texture and the feathers appear to be double, which is intelligible when we remember that in an ordinary flying bird there is often a small branch or aftershaft springing from the base of the main expansion or vane. If this aftershaft were to grow to the size of the vane we should naturally get a double feather.

The cassowaries include about ten species of large active birds with a curious projection or helmet on the top of the head. Both head and neck are bare and brightly coloured, and fleshy wattles are often present. Were a beauty competition set up for running birds, the cassowaries would undoubtedly take first prize, for the shining bluish-black plumage makes a striking contrast to the bright blue, red, and green of the naked head and neck. They are forest dwellers, very swift of foot, and defend themselves by kicking forwards with their powerful legs. The small wings, in which the quill feathers are reduced to spines, appear to aid progression.

The well-known doggerel which locates the cassowary on "the plains of Timbuctoo" cannot have been perpetrated by a naturalist, for these birds do not live in Africa. The largest species is native to north-east Australia and attains a height of about five feet. The other kinds are indigenous to New Guinea and some of the other islands north of Australia.



Autotype

THE QUEER KIWI OF NEW ZEALAND

There are several species of kiwi or Apteryx in New Zealand, which was cut off from adjacent land masses by the sea before any animals likely to be dangerous to this bird had migrated thither. The nostrils are near the tip of the beak, with which it captures earthworms. It is nocturnal.

The emus of Australia include two species, one eastern and the other western, and are larger than cassowaries, being over five feet high. There is no helmet, both head and neck are feathered, and spines are absent from the much reduced and apparently useless wings. These birds live on plains and in open wooded country, are swift runners, and defend themselves vigorously by kicking outwards and backwards

ROCS (*Aepyornidae*) included several species of four-toed running birds with much reduced wings which once inhabited Madagascar, and appear to have been distant relatives of the moas, and some of them were probably larger than the biggest of these. One or more of the smaller kinds appear to have lived on into the period of human occupation, to meet the usual fate of extermination at the hands of the natives. Exaggerated accounts of these creatures probably gave rise to various stories of a gigantic bird, the roc or rukh, to be found in the "Arabian Nights," the travels of Marco Polo, and elsewhere. Writing of Madagascar towards the end of the thirteenth century Marco Polo says:

> The people of the island report that at a certain season of the year, an extraordinary kind of bird, which they call a rukh, makes its appearance from the southern region In form it is said to resemble the eagle, but it is incomparably greater in size, being so large and strong as to seize an elephant with its talons, and to lift it into the air, from whence it lets it fall to the gound, in order that when dead it may prey upon the carcase Persons who have seen this bird assert that when the wings are spread they measure sixteen paces in extent, from point to point, and that the feathers are eight paces in length and thick in proportion

A French work of fiction, "Furteriana," published in 1696, says that the natives of Madagascar were obliged to walk about with tame tigers, to protect them from enormous birds that preyed on sheep and human beings One of H. G. Wells's most delightful stories, "Aepyornis Island," deals with this fascinating extinct type, which is at any rate unsurpassed among birds with regard to size of eggs, some of these being about thirteen inches long and nine and a half inches broad, with cubic contents of about two gallons.

American ostriches or nandus (*Rhaeidae*) include three species of three-toed running birds which live on the pampas of South America, from Patagonia to Bolivia and South Brazil. The wings are fairly well developed, and though useless for flight can be employed as sails to aid progression before the wind. These birds are much smaller than African ostriches, and do not possess the well-known ornamental plumes of the latter. Furthermore, the feathers have no aftershafts.

SOUTH AMERICA was an island-continent at the time when predaceous mammals were being evolved on the northern land-masses, so that but few of these are among its inhabitants. Like Australia and New Zealand, therefore, it has presented conditions favourable to birds abandoning flight and taking to a ground life. Little is known of the geological history of American ostriches, but in the remote past a considerable number of flightless forms existed in Patagonia, and these were often of large size, one of them *Phororhacos longissimus*, for example, possessing a massive skull two feet long. The body, however, was relatively small. There were four toes

African ostriches (*Struthionidae*) include three existing species, one in East Africa and another in South Africa, while the third and more familiar kind, the common ostrich (*Struthio camelus*) or camel bird ranges north into Arabia, Syria, and Mesopotamia, and formerly existed in Central Asia. It is about eight feet high, and runs far more swiftly than any other African animal, taking 25-foot strides, and aiding progression by spreading its small wings. Safety is promoted by the social habit, for ostriches are associated in small troops; and also by keen hearing and sight, which make it easy to detect approaching enemies, especially as these birds live in deserts or open country. When brought to bay they defend themselves with beak and legs. kicking sideways with great force.

African ostriches possess more specialised feet than any other running birds, for their toes have been reduced to two, the third and fourth, of which the former is much larger. The under sides of these toes are provided with elastic pads, as in camels.

It remains to enquire whether any more flightless birds are likely to be evolved in future. As regards ostrich-like types, the answer is distinctly in the negative, for they have no flying relatives to undergo such a transformation. It is not impossible that some of the existing rails which fly but little may ultimately become flightless, but this is unlikely. As we have seen, such adaptation to life on the ground has only taken place in isolated areas like Mauritius or New Zealand, in the absence of predaceous mammals; but pigs, dogs, cats, and stoats have now been introduced almost everywhere by human agency, thus doing away with the favourable conditions that formerly existed.

SHOULD future generations be able to record new flightless birds it is most probable that these will belong to the duck family (*Anatidae*), for aquatic forms are less exposed to enemy attacks than those which live on land. Many members of this family, such as swans, geese, ducks, and flamingoes, actually lose the power of flight for part of the year, for the wing quills are all shed at the same time, but they conceal themselves with great skill when in this comparatively helpless condition. One very interesting species, the steamer duck (*Tachyeres cinereus*), a form nearly as large as a goose and native to the Falkland Islands and the Straits of Magellan, is unique in the fact that it can fly when young, but cannot do so when adult. The Auckland duck (*Nesonetta aucklandica*) is also noteworthy in this connection It is a flightless form living in the Auckland Islands, a small group about 290 miles south of New Zealand, and closely resembles a duck (*Anas chlorotis*) native to that Dominion.

Chapter XIII

Vampire Bats & Their Harmless Relatives

By Frank Finn

Author of "Ornithological and Other Oddities"

ONE of our leading publicists once said that no matter what remarkable tale one told, facts would presently come along to corroborate it. Certainly this has been the case with regard to bats Man had long ago made up his mind that these harmless and useful little creatures were nasty, ill-omened things, when evidence turned up that bats really could be very objectionable, as the world and its animal inhabitants became better known. Moreover, the vampire legend of creatures far larger and more important than fleas, which practised blood-letting at nights, found a parallel in fact

The original vampire legend was of east European origin, and dealt with ghouls, generally supposed to be the ghosts of suicides and sorcerers, which left the grave to suck the blood of the living at night—generally those of their nearest and dearest—and these had to be duly exorcized to render them harmless, and the corpse, buried at a cross-roads for preference, kept quiet by a stake thrust through it.

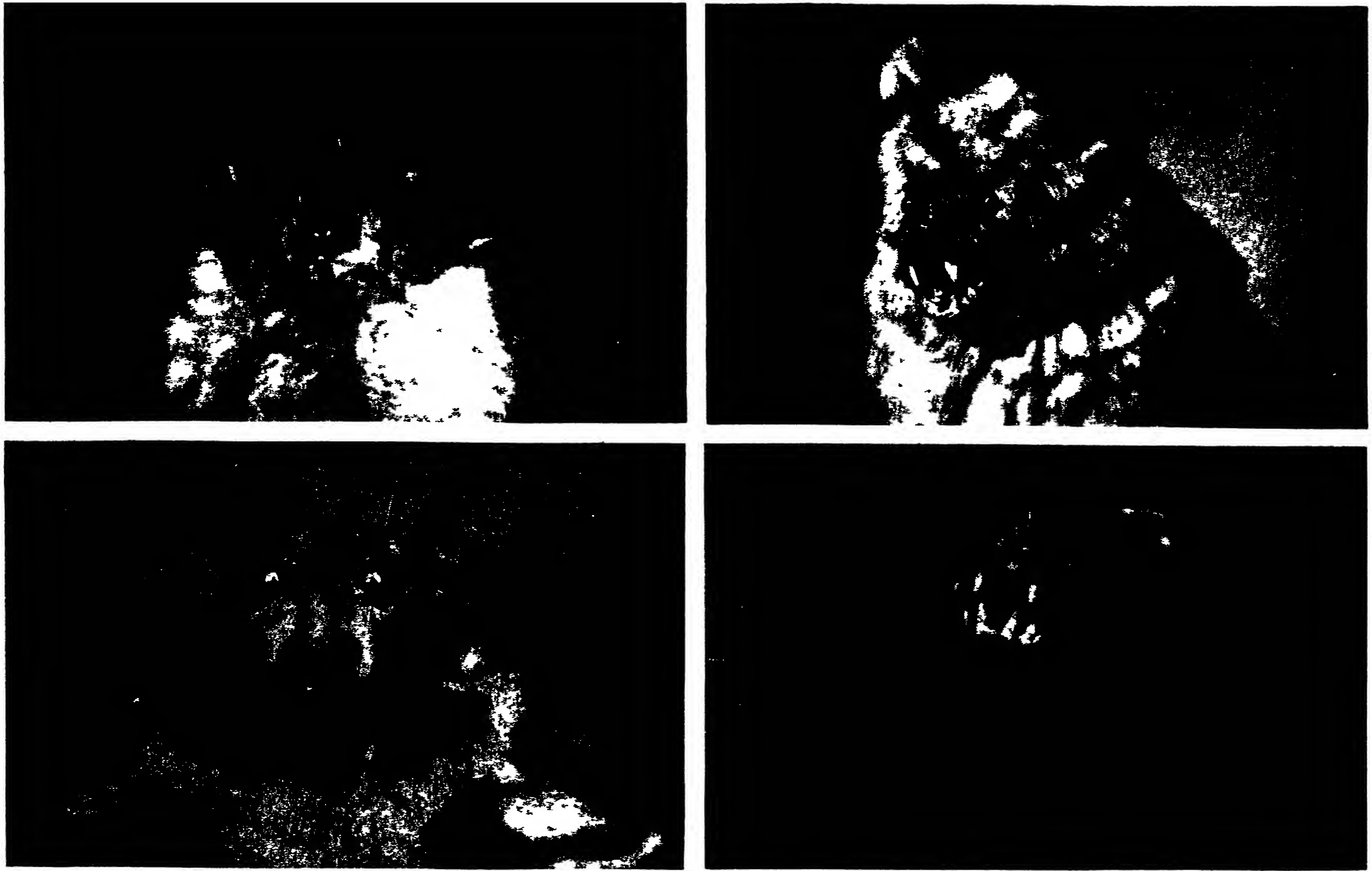
But when America was discovered it was soon found that there were living corporeal creatures which practised wholesale blood-letting, and that these were bats But centuries passed before the right bats were brought to book. As late an author as Linnaeus, whose "Systema Naturae," classifying all the animals and plants then known, was published about the middle of the eighteenth century, mixed up the blood-sucking vampire-bat with the kalong, one of the East Indian fruit-bats known as flying-foxes. His description of *Vespertilio vampyrus* credits it with sucking "the combs of cocks, the blood of sleeping slaves, and the sap of palms.' As the kalong is the biggest of bats, reaching five feet in span of wings, and has a head and fangs as big as a ferret's, its attentions to sleeping slaves would have been calculated to give these unfortunates a very rude awakening; while, as a matter of fact, the vampire was already known not to disturb the repose of its victims, and the East Indian locality was wrong for the real blood-sucker

Later on the charge was fixed on one of the vampire-bat's family, but not the right one, the accused animal being the spectre bat (*Vampyrus spectrum*), an ugly-looking creature enough, it is true, and large as bats go, but not half the size of the kalong, though a fruit-eater like it. Ultimately Darwin, who was just as great as a field observer and collector as he was as a philosophical theorist, succeeded in getting the real offender, his servant having actually captured a vampire on the withers of a horse as Darwin's party was bivouacking near Coquimbo, in Chile. This bat is the *Desmodus rufus*, and is not at all sensational in appearance, being only a little larger than our noctule or great bat, which is big as European bats go, but of about average size if the bats of the world are taken into consideration; while the only noticeable points about the blood-sucker's external appearance are the presence of a "nose-leaf" or flap of skin on the snout, and the absence of the tail and of most of the web that usually, in bats connects this with the hind limbs

THE BAT SLEEPS

This Australian fruit-bat, like the rest of the great family hangs itself upside down upon a branch by its toes. The bat therefore needs no nest or home of any kind and has a ready "take off" in case of sudden danger.

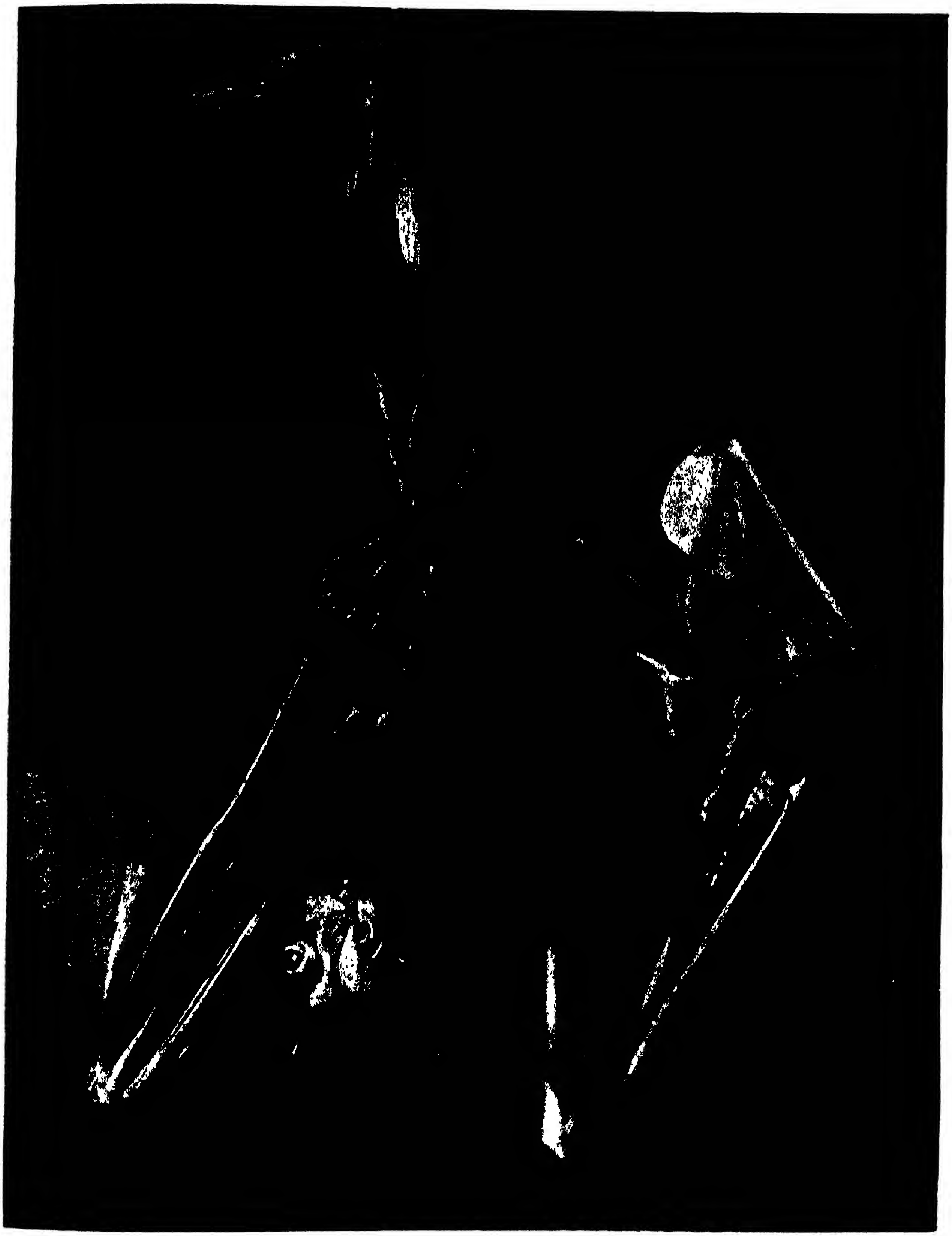
This true vampire's teeth are, however, very peculiar In bats generally the incisors are small and the fangs or canines large, as in carnivores, but in the blood-sucker the upper incisors and canines are both large and very sharp-edged, while the grinders, not being required by reason of the bat's liquid food, are reduced and unimportant. Thus the vampire is able to make a horizontal razor-cut, as it were, on the skin which severs numerous capillary blood-vessels and lets plenty of blood with no pain such as a vertical cut or puncture would inflict Then, as the vampire's meals are uncertain, the stomach is prolonged into a long, tubular pouch so that the creature can gorge itself and then fly away to digest its meal at leisure. The bat's intestine, by the way, is shorter in proportion than that of any other beast



W. S. Berridge

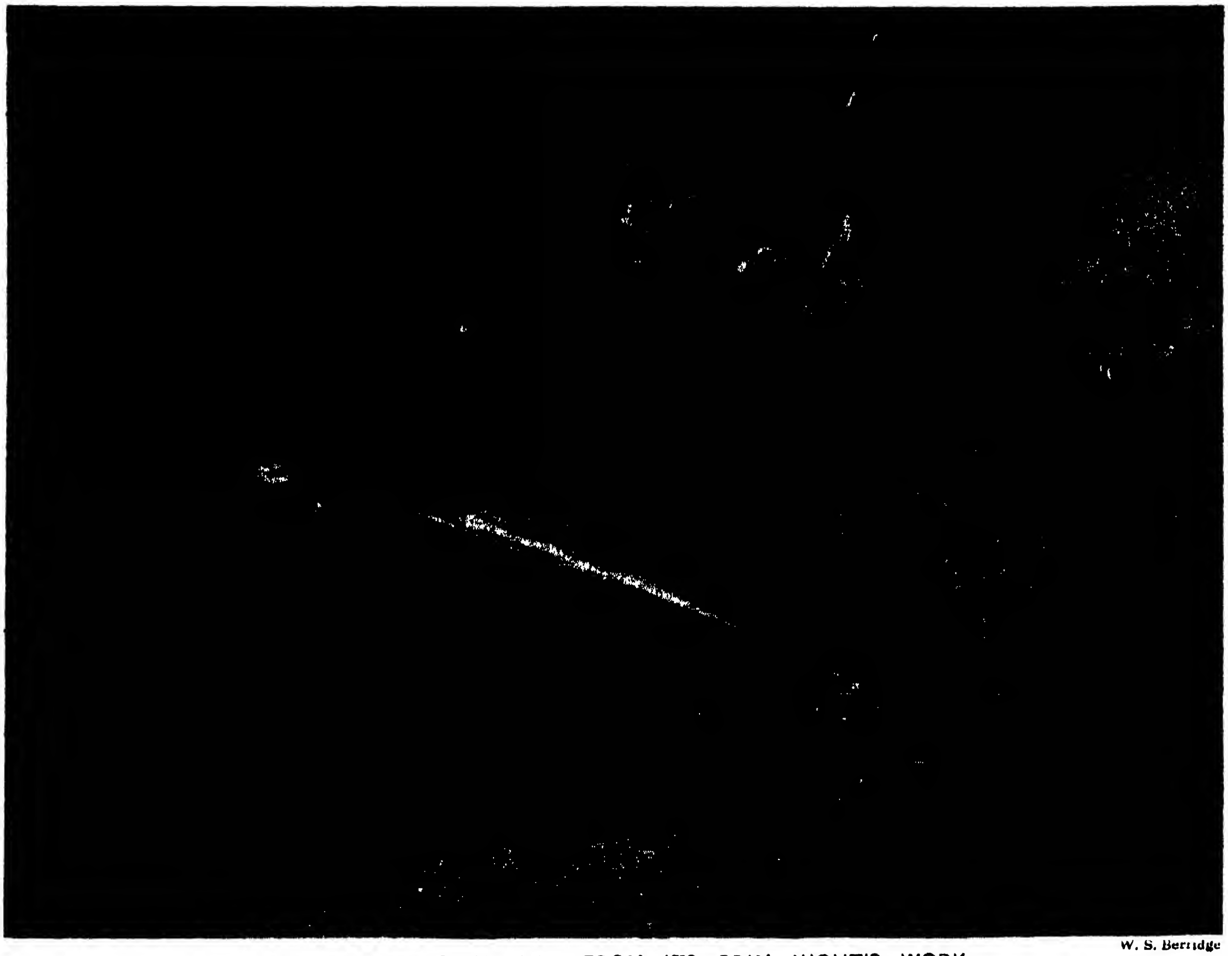
WINGED GROTESQUES. HIDEOUS BAT FACES LIKE THE GOBLINS OF A NIGHTMARE

Of all the mammals the bats are the most highly gifted by Nature They have developed a wonderful power of flight with wings which, for their size, are far more effective than those of birds, and besides this, they are equipped with a kind of "sixth sense" which enables them to avoid collisions in the dark The membranes of their wings and, in the case of the Leaf nosed bats (top right), the strange flap of skin covering much of the face, seem to be the seats of this strange power of sensation The Vampire bats of which we have a specimen here (bottom right), is confined to America and the West Indies. The other photographs show (top left) the false vampire, and (bottom left) the African epauletted bat



JAVELIN VAMPIRE OF BRAZIL HOOKED TO A TREE

Trunks of trees, especially if they be hollow, are favourite resting places for the javelin vampire which is believed to have a taste for blood. The javelin is distinguished from the other vampires by its short, broad muzzle, and the fact that it has two instead of three pre-molar teeth on either side of the lower jaw. In size this bat is only three to four inches long in the body, which is usually dark brown on the upper parts and pale brown below It spends the hours of daylight in this posture.



W. S. Berridge

VAMPIRE RESTS BY DAY FROM ITS GRIM NIGHT'S WORK

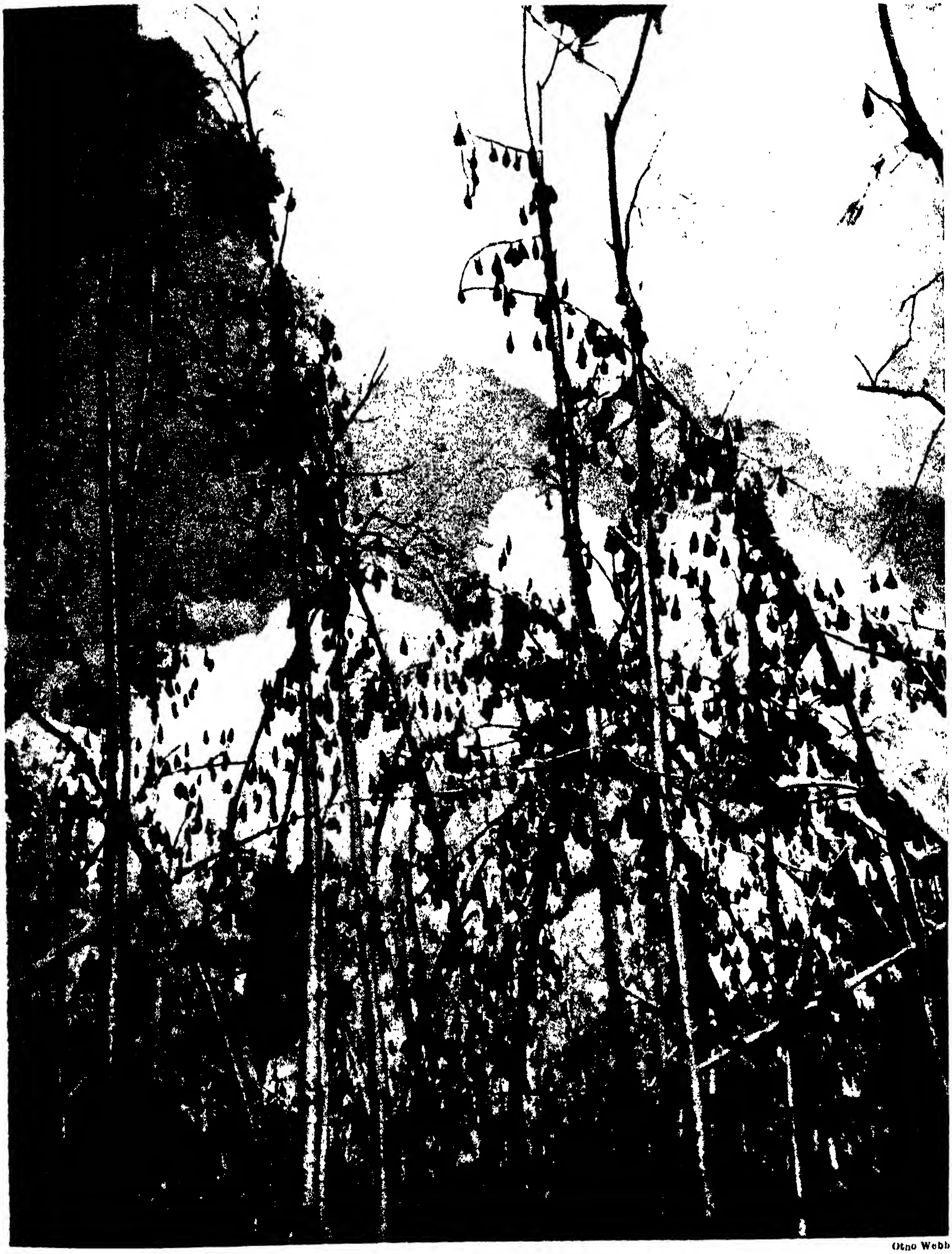
In former times when superstition was preferred to truth, men told grisly tales of a demon which came by night and sucked the blood of its victim. In South America the tale has come true and there is nothing more demoniac in Nature than the face of the blood-sucking vampire. The big toe is a favourite place for the gentle bite of those razor-sharp teeth which never wakes the sleeper. It is thought that, unless disturbed, the vampire's saliva helps to staunch the wound when its blood-thirst is quenched.

The vampire's victim is usually left bleeding, but a recent observer has stated that this is because the bat is usually brushed off at last, even if unconsciously, and that if it be allowed to have its own way it will fill the wound with its saliva, which coagulates quickly and acts as a styptic to stop the flow of blood, and also as a disinfectant. However this may be, the vampire's bite is very troublesome, if not dangerous, to people who are specially favoured by bats, while fowls succumb outright and horses and cattle are much weakened; the trouble in horses being aggravated by the fact that they are bitten just where the saddle is placed, so that a sore back is the consequence.

Light is said to keep the vampire away, and clear glass bottles, filled with water to make them heavier and suspended above beasts, are a deterrent, as the bats strike against them in the dark. Netting is the best preventive, and for travellers it should surely be possible to find some " dope " which could be applied to the portions of man and beast most liable to vampire attack and make them distasteful. In human beings the big toe is the usual point attacked, as it is likely to project from the bedclothes, but the vampire can make shift with the nose if the toes are inaccessible.

Only two other blood-sucking vampires are known, but the common species is found throughout the warm parts of America, so that bat-bites are likely to occur anywhere in this part of the world ; and so enterprising are the creatures that they even invade the guano islands off Peru, where they must look to the sea-lions and sea-fowl for a livelihood.

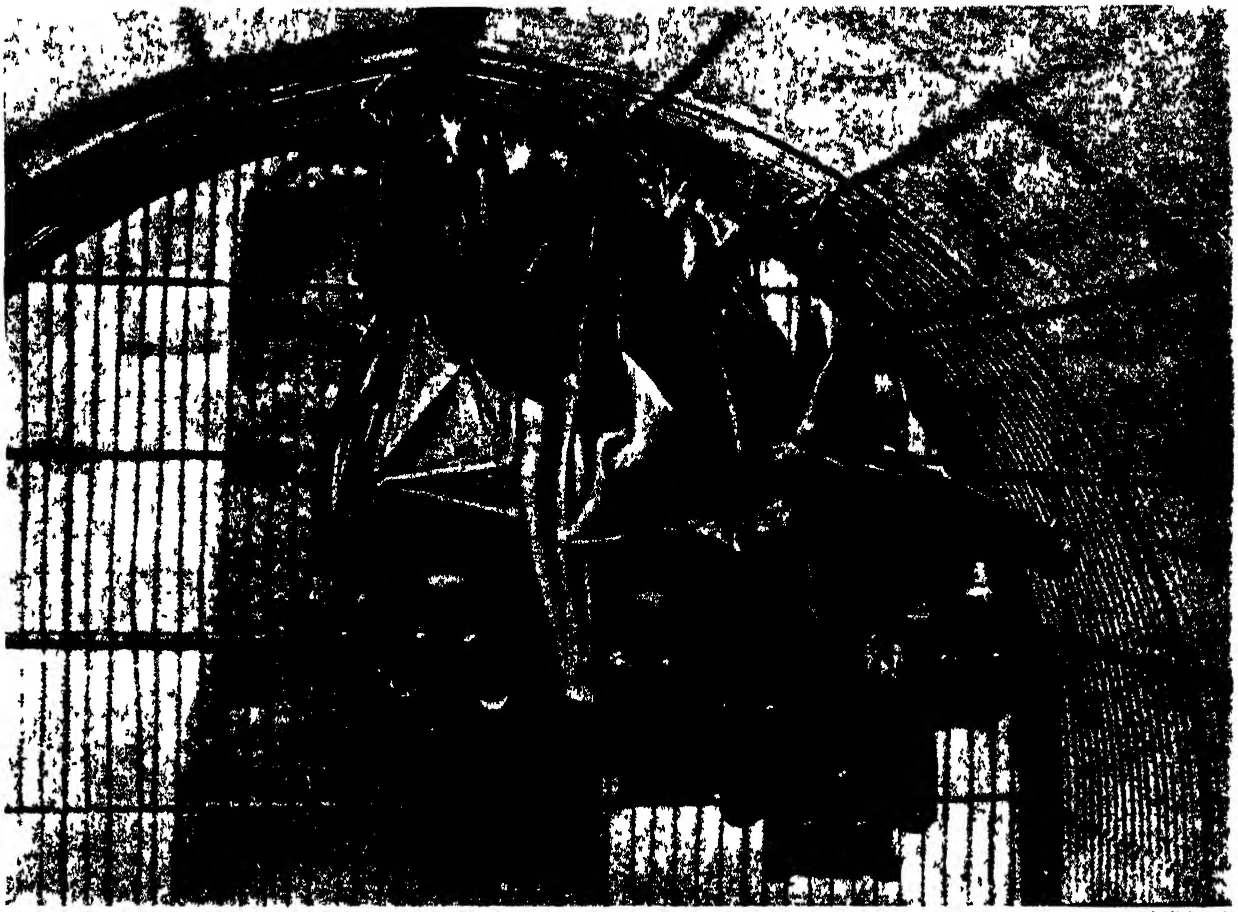
Incidentally, they have given a bad name to an innocent family, for the vampires generally are insectivorous or fruit-eaters, though one at least, Waterhouse's vampire, is a semi-cannibal, feeding on other bats smaller than itself. In this, as in some other points, it resembles the Indian fake vampire, or megaderm, a bat of another family, which was first convicted of being carnivorous by being found sucking the blood of a smaller bat. This is a thorough carnivore, preying on birds and lizards as well as



Otho Webb

A TREE IN AN AUSTRALIAN "BAT CAMP" BEARING A STRANGE CROP

In Australia the fruit-bats or "flying-foxes" congregate in "camps"—districts of woodland to which they always return to sleep. This particular "camp" in Southern Queensland covered about 25 acres and, as this is a photograph of only one tree, the number of bats in the whole "camp" can be imagined. In the evening the bats wake up and depart in search of food, darkening the sky with their swarms and filling the evening with the noise of their million beating wings. Woe betide the orchard which such a swarm may find in the picking season!



W. S. BERRIDGE

BATS BEHIND BARS: A MUSTER OF DOLEFUL FACES

The bat always sleeps in this inverted position with wings folded about the body like a cloak. To get the full effect of these six faces (the seventh bat shows only half a face on the extreme left) and six pairs of watching eyes and expectant ears as the shutter of the camera goes "click," turn the photograph upside down. Then we have a picture which might illustrate a scene from a story on the lines of "Dracula." The imagination of a Bram Stoker or an Edgar Allen Poe might well place this group discovered at the bedside by an awakened sleeper

smaller bats; it is a bone-cruncher more than a blood-sucker, devouring its prey in a wholesale hyena-like fashion. It also eats large insects, however, and an allied African species has been seen hunting insects by day and, what is more remarkable, making short flights after them and returning to its perch like a flycatcher, whereas most bats, as everyone knows, resemble swallows in their hunting habits, and remain for a long time hunting about on the wing.

One does not hear complaints of the fruit-eating vampire's depredations, but the great fruit-bats or flying-foxes are very troublesome in this way; in India the one local species of flying-fox, which is the next largest bat to the kalong, does a great deal of harm to fruit, and Australia suffers from no fewer than five species of flying-foxes, all enthusiasts for the slogan "Eat more fruit." They assemble in thousands in roosting places, or "camps" as the Australians call them, and an Australian scientist one year sent out an S. O. S. asking for suggestions for their destruction, especially for a "biological check." But such a check would be hard to find, for bats as a group are singularly free from enemies, as is shown by their great numbers in the tropics.

A small insectivorous species in Burma, the wrinkled-lipped bat, comes out of the caves in which it shelters in masses which look at a distance like clouds of smoke, and further east a flight of flying-foxes has been seen which darkened the sun, and was estimated to number half a million individuals—and this in spite of the fact that bats are not prolific, usually having only one or two young at a time, and that only once a year.

Even destructive man has so far been powerless against bats, though in some parts of Africa and the East they are much hunted by him for food; and bats were eaten in ancient times, for it is recorded that the citizens of the old town of Borsippa in Mesopotamia ate salted bats; while the prohibition of the bat as food in the Mosaic law shows that the lawgiver looked on bat-eating as a possibility.

As the Indian flying-fox at any rate does drink the sap of palms, when it can find the pots in which the natives collect sap for toddy, and gets incapably drunk on it when, in the hot Indian night, the juice

J. J. Ward and W. S. Berridge

HOW THE LONG-EARED BAT PREPARES FOR BED

Among the bats of Britain is this species which is remarkable for its ears, so huge in proportion to its body. The bat is commonly about two inches long and it has ears one and a half inches long. When it decides to sleep after its nightly flight for food it hangs itself up, folds up first one ear and then the other under its wings and so, warm and comfortable, it spends the day. The colour of this species is brown-grey above with lighter under parts, the shade of colour varying to some extent with the individual.

Otho Webb

"CLOSE-UPS" OF THE FRUIT-DESTROYING "FLYING-FOX"

So devastating have the ravages of the fruit bat or "flying-fox" become in Australia that in 1920 the Queensland Department of Agriculture experimented with that hideous engine, the flame-thrower, to check the pests. The lower photograph gives the proportions of the animal and above (top left) we see the sleeping position and the way in which the thumb is separated from the fingers, which support the wing membrane, and is used for climbing and hanging. The other photograph shows the bat's resemblance to a fox.

W. S. Berridge

PHILIPPINE FLYING-FOX AND THE NOCTULE OF BRITAIN

A species of flying-fox or fox-bat (bottom) is found in the Philippine Islands and, as can be seen by a glance at its long muzzle, the term is a very suitable one. The contrast between the face of this fruit-eating type and that of the vampire and insect-eater is very marked. The noctule (top) is the most familiar of the bats seen in Britain and is also known as the great bat. Its wing-spread is usually about thirteen or fourteen inches. It inhabits trees and is particularly fond of cockchafers, its teeth being specially suited for crunching them.


W S BERRIDGE

THE SEROTINE, MOST WIDELY DISTRIBUTED OF BATS

Both the Old and the New World are inhabited by the serotine, the only bat indigenous to the two hemispheres. It is found in the southern counties of England and can be known by its slow and fluttering way of flying But specimens in England are rather rare The usual colour is chestnut brown on the back and the hair is long and of a silky texture.

has fermented into toddy on the tree, it seems as if a good plan would be to establish a free canteen in every bat-camp, when the debauched delinquents could be dealt with at leisure. It ought to be possible to put them to some practical use, and the writer is inclined to think that their broad, naked wings would make a very useful fine leather, he fears it would be of no use to suggest bat-eating to white Australia!

It is a pity that any bats need to be put out of the way for conflicting with human interests; for their race is in many ways one of the most wonderful and perfect products of evolution, and we ought to have some fellow-feeling for them, since of all animal aviators they are the nearest in structure to ourselves, and they have solved the problem of existence admirably, as their abundance shows.

Though sociable, bats are not in the least socialistic—in fact, they are decidedly quarrelsome; yet, more than any other animals, they have freed themselves from the ties of property. Other beasts and birds need some sort of den or nest, or have lively straggling youngsters to look after, but all the bat needs is something to hitch his toe-nails on to. His flexible wings, wrapped round him, serve him as bed-clothes, and his mate carries the batling clinging to her breast even when she flies out to forage. The feeding habits of bats, also, are very wide, though most are useful insect eaters, many, as we have seen, are fruitarians and a few carnivorous. One or two, in tropical America, even catch fish, snatching them up with their hind claws like a fishing hawk; and even the fruit-eating flying-fox has been once seen to do this in India, while a smaller fruit-bat in Burma has been found feeding on shell-fish when the tide was out.

Thus, although they came into existence ages after birds had won their wings, bird competition seems not to have troubled them, and they have almost as varied a diet as birds have, while in some respects they beat birds as flyers; if none can fly so fast or so far as some birds can, no birds but the humming-birds can beat them at dexterity in evolutions in a small space. Even the comparatively clumsy fruit-bats are difficult to tire out in a room, where almost any bird soon succumbs; the reason of this being that a bat is much better at the turn, for its wings embrace a far larger amount of air, although its provision of muscular power is ridiculously small in comparison. A bird with breast-muscles no larger than a bat's is the poorest of flyers; but the skin of the bat's wing extends all down the flanks and legs to the ankle joint, in addition to the web which joins the long wire-like fingers.

Fragile as the bat's wing looks, it has great resisting power; the flying-fox slogs its way across the sky with a slow sweeping stroke which makes its flight far more impressive than any bird's, and the sudden doubles and wrenches of the ordinary little flitter-mouse look as if the filmy wings ought to snap under the strain. The bat's wing must be, indeed, in some cases, easily thrown out of gear. One may often see a bird flying with a great gap in one or both wings which re-growing quills will soon repair; but one never sees a damaged bat abroad.

Probably a broken finger-bone or a slit in the wing-web means disablement to a bat; and probably, too, the quarrels of bats among themselves lead frequently to such injuries, and are the most powerful check on their increase—like so many very successful animals, man included, their worst enemies are their own kind. For a bat that cannot fly is doomed, since bats have staked their all on their wings; they not only cannot stand on their hind limbs like birds, but they cannot even stand up on all fours like other beasts, but are limited to crawling. Hence, although they are not unable to rise from the ground, they avoid a flat surface, and are much more at home when they can hang up by toes or thumb-nails, the toes being preferred, as the upside-down position allows them to wrap themselves in their wings, and also affords a better take-off for flight, which otherwise would have to be begun with a back-somersault; such a somersault on settling they do not mind, for in Nature it is being "quick off the mark" that matters most.

The thumb is the only finger of the bat's fore-paw that has no part in the construction of the wing, it is strongly clawed, and is used not only for climbing, but at times for fighting, and even for picking up or holding food. The hind-limb is also very wonderful in its way, for it has the same freedom of movement as an arm, while the foot turns as freely as our hand, and yet the whole limb does the usual hind-leg duty in the straddling crawl which is a bat's walk.

The wing-web of bats is for the most part naked, though some show a certain amount of fur on the sides near the body and on the tail-web, and this

naked wing is extraordinarily sensitive to temperature and air currents. Thus the bat's sense of touch is as superior as ours, as are the dog's scent and the hawk's sight, and the creature need not touch an object to be aware of its presence. So it is that bats deprived of sight are able to fly freely about and avoid even such small obstacles as suspended strings.

That they should sometimes collide with glass is conceivable, since glass is a substance unknown in nature, and is, moreover, very permeable by heat, so that to the bat, feeling its way by temperature, it does not represent an understandable obstacle. Just so, the keen-sighted hawk is captured in a net, which it must see but cannot understand. This sense of feeling is most developed in bats that have well developed "nose-leaves," and these often have particularly small eyes. In fact, the bats as a group are remarkably small-eyed, with the exception of the old-world fruit-bats, which are large-eyed, and probably fly mostly by sight, though, as some of them roost in caves, they are no doubt also able to find their way in the dark.

Birds had a long start of bats in evolution, and no doubt the danger from birds of prey is the reason why parachute flyers are nocturnal, because a creature which glides passively through the air is simply inviting trouble from such enemies; and even now, those few birds of prey which take bats seem to have little trouble in securing them. That they are not more partial to bats as food is probably due to the fact that bats, as compared with rats and mice, are not only harder to catch, but are poor value when caught, owing to their large expanse of tasteless, skinny wings. Just so, the broad-winged slim butterflies are seldom troubled by insectivorous birds, while the more meaty moths are ravenously pursued.

The nasty smell of bats is very likely another reason why they are but little preyed upon; and this, no doubt, is also one of the peculiarities which have tended to prejudice man against them, others being their crawling movements and soft, naked, skinny wings, which suggest clamminess, to say nothing of their ugly little faces, which in many cases attain a pitch of goblin hideousness like nothing in nature, suggesting the devil-masks used by Buddhist monks in certain ceremonies.

The flying-foxes, with their keen, intelligent-looking, dog-like heads, inspire nothing but friendly interest when seen close at hand, and might quite probably be popular as pets if they were better known. A flying-fox kept as a pet in London has been known to live twenty years.

Another peculiarity operating against bats in human estimation is the fact that they are generally not easily studied, for people are always ready to distrust what is unfamiliar. But it cannot be said that the bat fairly exemplifies the proverb · "Give a dog a bad name and hang him," for the first bats, found fossil, are perfectly well-developed according to their kind, and many strange beasts have arisen and become extinct since their day; so the bat had hung himself happily by the heels for ages before our own ancestor, starting from a little quadruped which must have been very similar to the bat's, had begun to sit up on his hind legs and take notice.

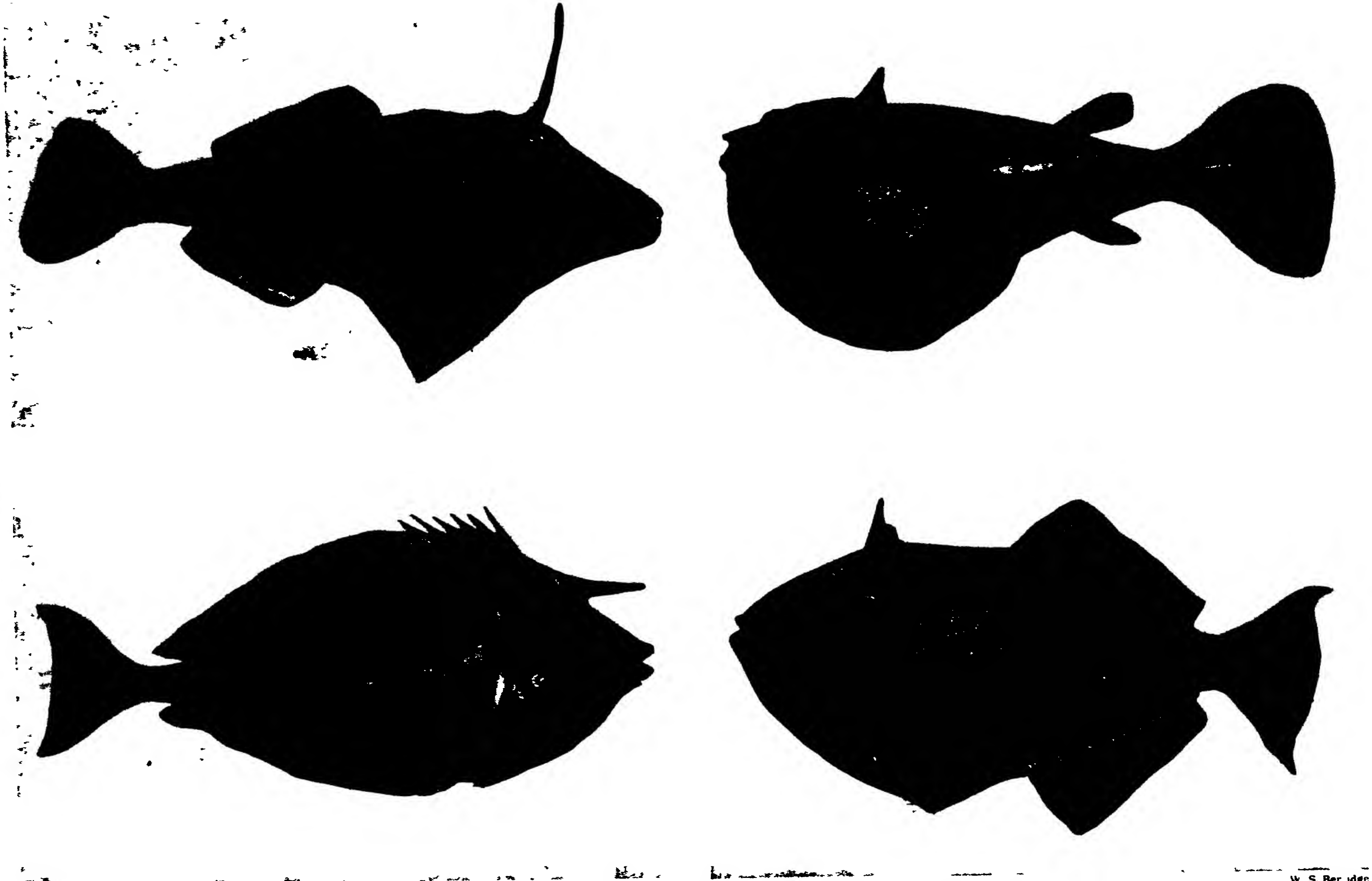
Even among scientists legends about bats still exist. Many seem to think that their flight is in some way different from and inferior to that of birds, but instantaneous photographs of flying-foxes on the wing show that the movements of the wings are quite similar, and one of these great bats has boarded a ship two hundred miles from land. As has been pointed out, the bats can claim to have more thoroughly mastered the air than their rivals. Every animal, it has been said, has some strong point or it could not live, and some weak point or the others could not live; the bats have an extraordinary number of strong points, but two weak ones—they have no power of resisting cold, and they have rarely developed the instinct of migration.

Thus they are mainly creatures of the tropics; in India there are more than a hundred species, in Europe less than a quarter of that number, none of them of really large size. But at all events, here they are purely the friends of man, and we have nothing to fear from the orchard-raiders and blood-suckers whose misdoings are the only justification for the disfavour meted out to these, the most highly-gifted children of Nature after ourselves.

W S Berridge

HIDEOUS HAMMER-HEAD

Found in the Gabun district of French Equatorial Africa, the hammer-headed bat is characterised by a relatively enormous muzzle of extremely repulsive aspect. This bat is a fruit-eater with a very great partiality for figs.



W. S. Berridge

UNCOUTH AND BLOATED FORMS OF THE UNICORN, FILE, TRIGGER, AND GLOBE FISHES

On account of the stout spike protruding from its head, close to the large glaring eye, the unicorn fish (bottom left) gets its name. The trigger-fish (bottom right) and the file-fish (top left) are of the tropics and belong to the same group in which the shape has been distorted from length to breadth, especially in the case of the file-fish. This has the first of the dorsal spines roughened like a file in front and is equipped with strong teeth with which it can bite off lumps of coral whence it sucks the soft organisms within. The trigger-fish cannot lower its first long dorsal spine until the second, which is much smaller, has been lowered, and from this fact it has been named. The globe-fish (top right) is related to the sun-fish and swims in tropic seas.

Chapter XIV

Nightmares of the Sea

By J. Travis Jenkins, D.Sc., Ph.D.

Lecturer in Sea Fisheries, Liverpool University

DURING thirty years' sea-fishing of all kinds, in the pursuit of fish and marine creatures from shrimps to whales, in seas extending from the Arctic Circle to the Tropics, I have come across fish of amazingly grotesque appearance, many of which can only be described as terrifying.

This fact is reflected in the popular names applied to certain species ; for instance we have sea-devils or devil fish, hag fish, scorpion fish, dragonets, toad fish, fishing frogs, crocodile fish and sword fish. Even the scientific names of many species record these peculiarities in such suggestive terms as *monstrosus*, *horridus*, or *infernalis*.

Mere size is not an attribute of ugliness or fierceness since some of the smallest sea fish are of truly terrifying aspect, for instance, the sea-scorpions. The ferocious appearance of these sea robbers is mainly due to their bizarre shape and the presence of formidable spines, but to some extent to the coloration. Many fish can assume a warning attitude or a bullying expression by erecting their spines or deepening or changing their coloration.

The question naturally arises as to the utility of this formidable aspect. Are these fish really ugly and repulsive from the human point of view only, or is this horrifying appearance of some use to its possessor in the struggle for existence, which is constantly going on in the sea as elsewhere ? The question does not admit of a simple answer, since ugliness in fish undoubtedly serves many purposes, which can be more appropriately considered in each separate case, but broadly speaking a sense of terror or warning is conveyed by the fish's appearance, and this sense of terror is a source of usefulness to the fish invoking it. Ugliness is nearly always associated with what is harmful or dangerous.

Some fish are actually poisonous, others are capable of giving an alarming electric shock, and in these cases the coloration and appearance of the fish serve as a warning. In other cases, where the males and females are of markedly different appearance, the males are the more ferocious-looking and this serves more than one useful purpose.

To estimate the effect of terror or fright on fish we must remember that water is much less transparent than air, and frequently sea and fresh water is more or less cloudy. Compared with human beings, fish are short-sighted. The lens of the eye is spherical or globular, and the range of perfect vision cannot be more than a few feet. Consequently, in order to escape from its enemies all a fish has to do is to make a short and swift dash out of its enemies' sight. In the great majority of cases this is sufficient, and the muscular arrangement of the fish's body secures this sudden dart out of sight. Were it not so, it is difficult to see how such defenceless fish as mackerel or herring could survive, in spite of their enormous fecundity. The effect of the monstrous or horrible appearance of a large number of species of fish is therefore unquestionably in use to frighten away or warn off other species.

Take, for instance, the sea-scorpions, which are for the most part small coastal marine fish, common enough in British waters. They are poor swimmers and consequently their unattractive appearance and numerous spines, together with their habit of swelling themselves up, is doubtless a protective measure and prevents their being attacked by larger fish. Moreover, these fish lay a mass of eggs which undergo a period of incubation lasting approximately a month. During this period the eggs are liable to be devoured by other species and would be, but for the fact that the male parent constructs a sort of nest and mounts guard over the eggs until the young are hatched out.

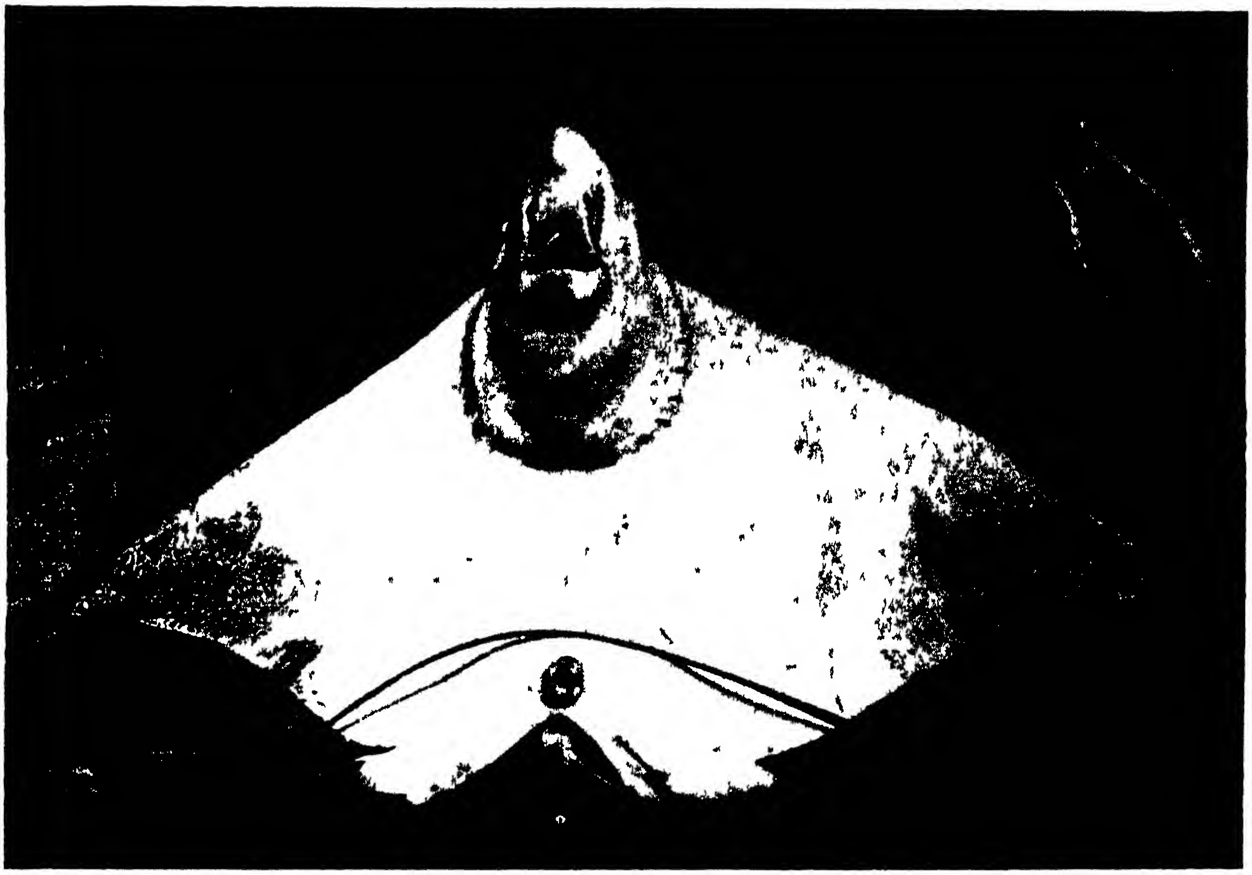
The sea-scorpions are also remarkable for the fact that they are able, under the emotions of greed, anger, or fear, to change their colour. When the male of the short-spined sea-scorpion is sitting on the eggs, it presents a truly formidable appearance for a fish so comparatively small in size.

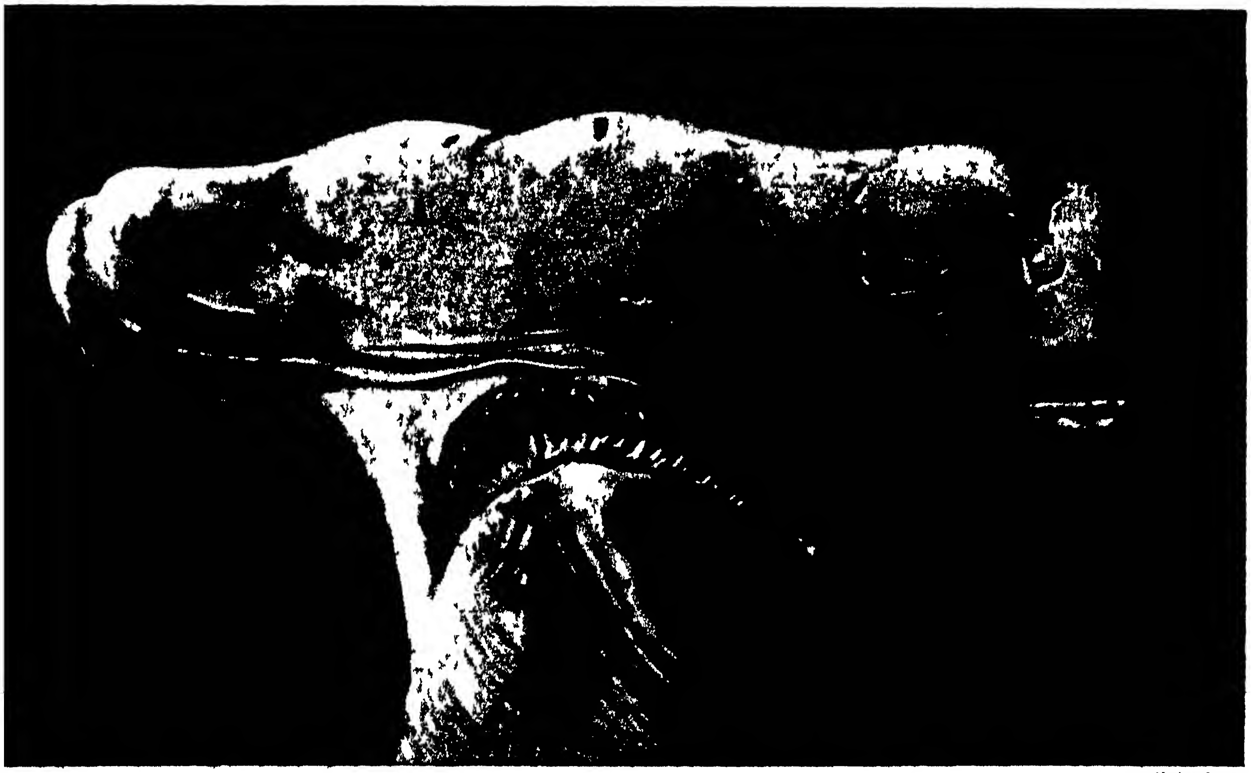
THE Gobies are also small fish, frequenting for the most part rocky coasts. Their aspect is, considering their small size, formidable, and one species rejoices under the scientific name of *Scorpioides*, that is to say " like a scorpion."

These fish are both shy and pugnacious, and there is a marked difference in appearance between the males and females. They are among the very few fish which have a period of courtship, during which time the male assumes a bullying attitude, fighting with any other male which dares approach him. Here the fish actually pair off together for a time, and it is certain that the terrifying aspect of the male, combined with his pugnacious character, is of importance in driving off rivals and in assisting him to the happy end of a successful wooing.

The term cat-fish is applied to several kinds of fish, which have nothing in common except their repulsive appearance. The common sea-cat or sea-wolf is a marine species inhabiting deep water to the north and west of Britain and is most frequently seen in the Aberdeen market. It is really a giant blenny, attaining a length of over six feet. Of blue-grey colour with black bands down the sides of the body it is the only cat-fish which even remotely resembles a cat.

There is a family of fresh-water fish, the Siluroids, not represented in British waters, to which the term cat-fish is applied. They are abundant in Indian rivers and are really of quite exceptional ugliness. But of all the disagreeable fish of the tribe the chaca





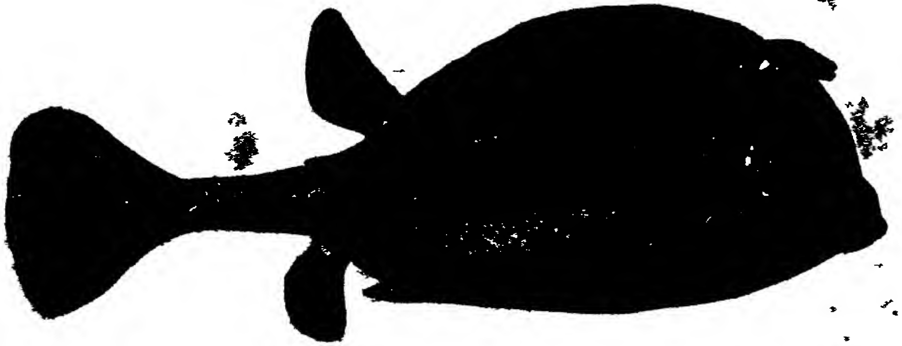
Dr Haden Guest

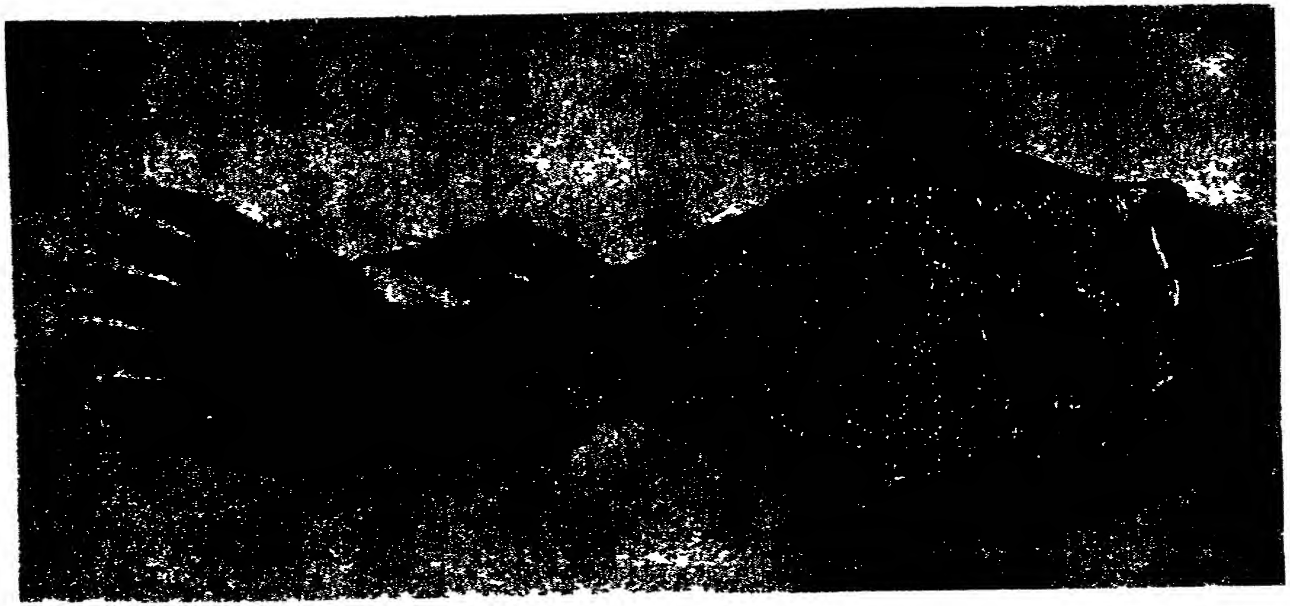
WHIP-TAILED EAGLE RAY AND THE JAWS OF A HAMMER-HEADED SHARK

When captured the eagle ray (top) is extremely dangerous on account of its long, whip-like tail which ends in a jagged spine that is capable of producing a very ugly wound Eagle rays grow to a length of about fifteen feet and feed on clams and oysters, their jaws having a terrific power of pressure. The hammer-headed shark (bottom) is one of the most dreadful looking fish, for it has its head prolonged on either side and at each extremity there is an eye This shark is said to feed on the rays and to be indifferent to wounds from the spines or "stings"

THE GHASTLY HORROR WHOSE NAME IS DEVIL FISH

Two tons of devil fish upon a truck make a sight that is better not remembered in one's dreams. Considered as a sight this thing is frightful but when we come to examine it as a fish, there are several points to be noted. Firstly, what looks like a horribly bloated face is really the underside of the head. Notice the mouth with the strange teeth adapted for crushing shell fish. Secondly, the slits above are not eyes but gill-clefts, the eyes, invisible from this point of view being on the upper side of the head as in the case of a shark.

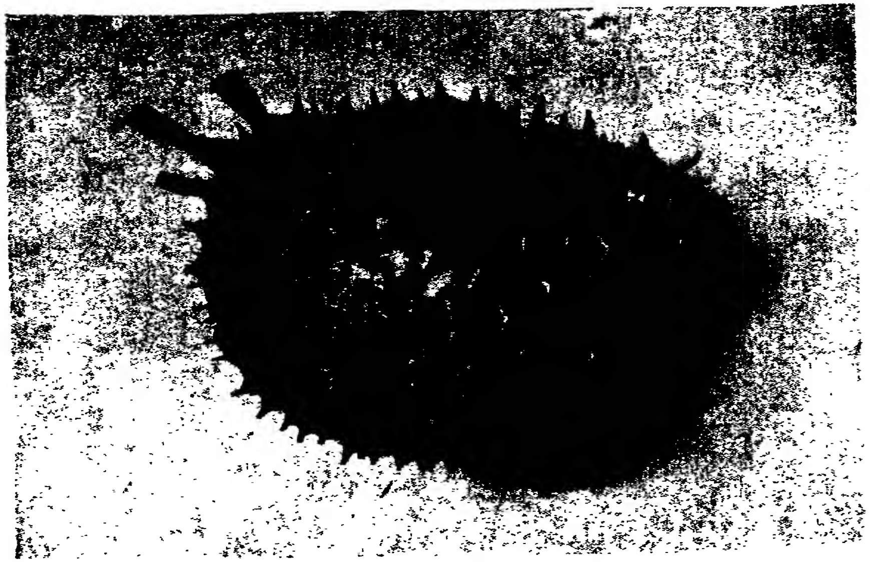


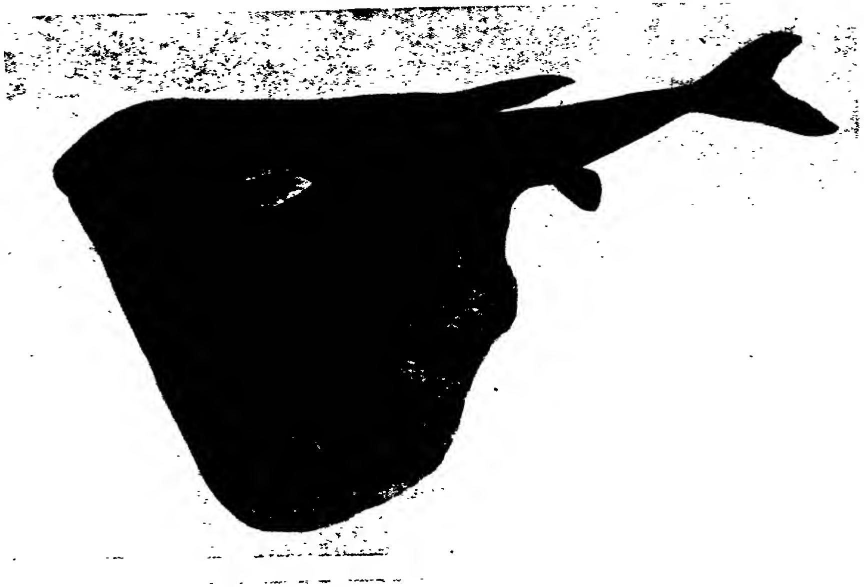


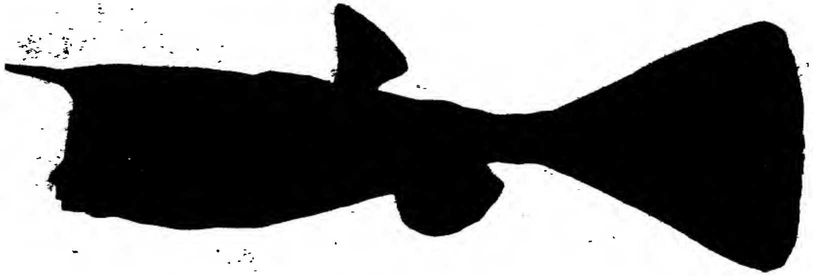
W. S. Berridge

FOUR OF NATURE'S FREAKS FROM THE DEPTHS OF THE SEVEN SEAS

Taken by a British trawler off Iceland in the course of its fishing there was this specimen of the Ceratius (bottom left) which is a very strange fish. This is a female and something over three feet long. The male, four inches long, is seen attached, and looking, at first sight like a small fin projecting below. This male is carried about by its huge mate as a kind of parasite. On the female, where the dorsal fin in many fish could be, is a kind of rod and line complete with bait with which the weird fish fishes. The sun fish (bottom right) is a strange travesty of the fishy form, and above we have a specimen of the four horned trunk fish (top left) and (top right) the oddly fashioned frog fish







W. S. Berridge

TRAVESTIES OF FISH SHAPES THAT SWIM THE WARM WATERS OF THE TROPICS

While the fish of the frigid and temperate zones are usually sober hued, the vital warmth of the tropic and sub-tropical sun seems to produce bright colours and strange shapes, as well in the sea as on the land. The trunk-fish (bottom right) and the sac-fish (top right) are good examples, the latter haunting the Indian Ocean. The skin of its stomach is elastic to an extraordinary degree and, at full stretch, gives its owner a grotesque appearance. The sac can be blown out with air to alarm attackers. This fish is not more than twenty inches in length. The gurnard (bottom left) is found not only in tropic seas, but in British waters. Despite its appearance it is excellent eating. The remaining photograph (top left) shows a globe fish.

Dr Helen Guest

NIGHTMARE OF THE SEA IN THE LIGHT OF DAY

All those who are inclined to smile nonchalantly at the angler should remember that the sort of fishing which involves the "playing" and capture of a tiger shark is by no means to be lightly spoken of The name of this fish is, incidentally, in all save ferocity, a manifest libel on one of the most splendid looking of beasts

is the most horrible to behold. It conceals itself in the river mud from which it is in colour hardly distinguishable. A number of loose filamentous projections on the skin serve to camouflage it. With wide-open mouth it remains hidden in the mud waiting to pounce on any fish that may happen to wander within reach of it. It is of truly loathsome aspect.

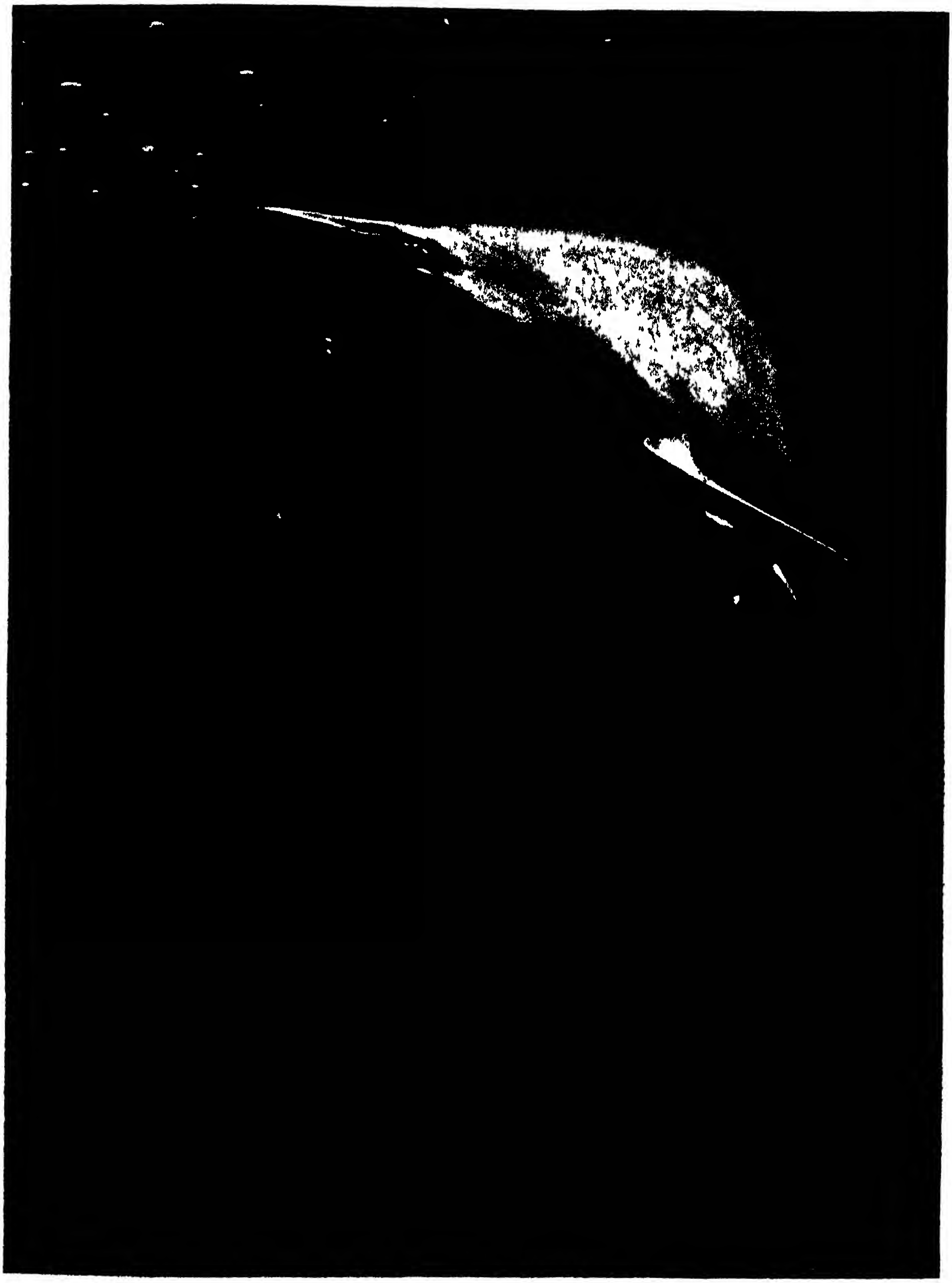
There are at least two species of Horrid fish The horrid sea-scorpion (*Synanceia horrida*) which belongs to quite a different family from the sea-scorpions above mentioned; and the king of the herrings, or rabbit fish (*Chimaera monstrosa*). The general appearance of the horrid sea-scorpion, especially of the head, can only be described as monstrous and here again trespassers are warned off, since these fish are provided with poisoned dorsal spines. These spines are in their terminal portions provided with a deep groove on either side at the lower end, in which is a pear-shaped gland containing a milky poisonous fluid. The wounds made by these fish are often deadly. The family to which they belong—the *Scorpaenidae*, or sea scorpions—comprises the ugliest collection of sea-monsters available. As they are all of carnivorous habits and extremely voracious, their mere appearance is a sufficient warning. Of the habits of the king of the herrings very little is known.

A few fish are provided with poison glands, similar in function to those possessed by poisonous snakes, and if these fish are handled incautiously when alive they are capable of inflicting a wound which in extreme cases may be fatal to a human being, and in any case produces partial paralysis or numbness which may last for months.

These poison glands are not associated with the teeth or fangs of the fish, but with spines which are situated either in the back fin, as in the weevers. or in the tail as in the sting rays. These poisonous fish have a very unattractive appearance and are doubtless repellent in respect to other marine fish The Weever family, which includes two British species, is particularly repulsive, some of the tropical forms having a large, broad, thick head with upturned eyes with a strong resemblance to a bulldog. The abyssal dragon (*Bathydraco*) belongs to this group.

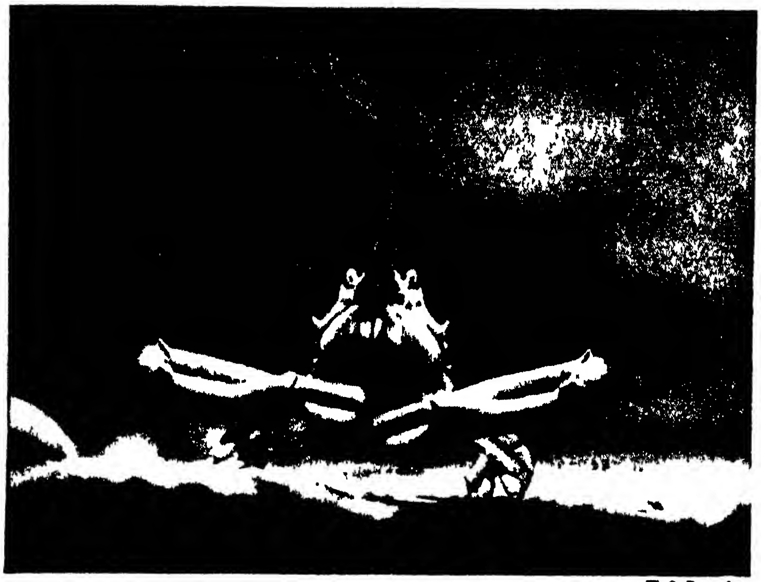
The sting rays or devil fish have a formidable barbed spine behind the fin. These fish are of enormous size and we frequently took them in the trawl in the Bay of Bengal. Specimens up to twenty feet in breadth, measured across the back, were not uncommon and it was impossible to approach them until they were dead on account of their terrific struggles and lashing blows of the barbed tail.

Nature has provided these poisonous fish with a warning appearance. When the weevers are alarmed they erect their dorsal fin, which is not only poisonous but deep black in colour. They bury themselves in



FINNED DEATH THAT MOVES IN THE TWILIGHT UNDER THE WATERS

Out of the dimness of the sea there comes suddenly an evil shape, built for power and speed. The head ends in a point like the blade of a spear and at its base are two eyes which never change from their one fixed expression which means hunger. Beneath comes the mouth, furnished with ghastly sets of teeth to serve this thing which seems made only for horror And yet the shark is neither more nor less dreadful in its own sphere than the everyday cannibal trout of a pleasant English stream.



W S Berridge

very deepest waters of the oceans where one species, *Saccopharynx*, has such an extraordinarily distensible stomach that it can swallow a fish several times larger than itself. All eels are very voracious. They are provided with formidable teeth, and there can be no doubt that their repellent aspect is a warning to others to keep away. In the sea, eels attain a length of at least sixty feet with a maximum thickness of eight feet and there can be little doubt that the occasional appearance of these gigantic eels at the surface is one of the origins of the famous and persistently recurring stories of sea-serpents.

The members of the Globe fish family are provided with spines. They are also able to swallow air and so assume a globular form. This peculiarity has

the sand so that this fin only is visible, and is a most effective protection against and warning to predaceous fish. Similarly an Indian cat-fish (*Plotosus*), which is armed with dangerous spines, wounds from which are much feared by the natives of India, since they cause severe inflammation or even tetanus, is provided with a breast fin brilliantly coloured in red and yellow, the erection of which by the fish is undoubtedly a warning device.

Generally speaking, poisonous or other dangerous fish avoid their enemies. This is understandable when we realize that the poisonous fish itself suffers more or less serious injury when its spines penetrate the skin of another fish or animal, since they are often damaged or torn away altogether. So that many of them, but not all of them, exhibit warning coloration. The electric eels and the Scorpenoids, for instance, are not specially provided with any particular warning colours.

ANGLER FISH AND THE MASKED CRAB — E Step

Provided with a "fishing rod," a kind of tentacle growing out of its head the angler-fish (bottom) waits concealed until some passing fish is attracted by the flap of skin at the end of the rod. As soon as the victim comes within reach it is snapped up within those evil toothed jaws Above we see the head of a masked crab.

The muscular system in some fish is modified in a peculiar fashion so that electric organs have evolved out of the muscular substance. Such fish are capable, when alive, of giving a severe electric shock to other fish or animals. In British waters the only species is the torpedo fish or electric ray, but in foreign waters the electric apparatus is encountered in other forms, and we have an electric eel and an electric sheath-fish of the fresh waters of tropical Africa. In all cases these fish have an unattractive appearance and coloration which undoubtedly have the effect of warning off intruders.

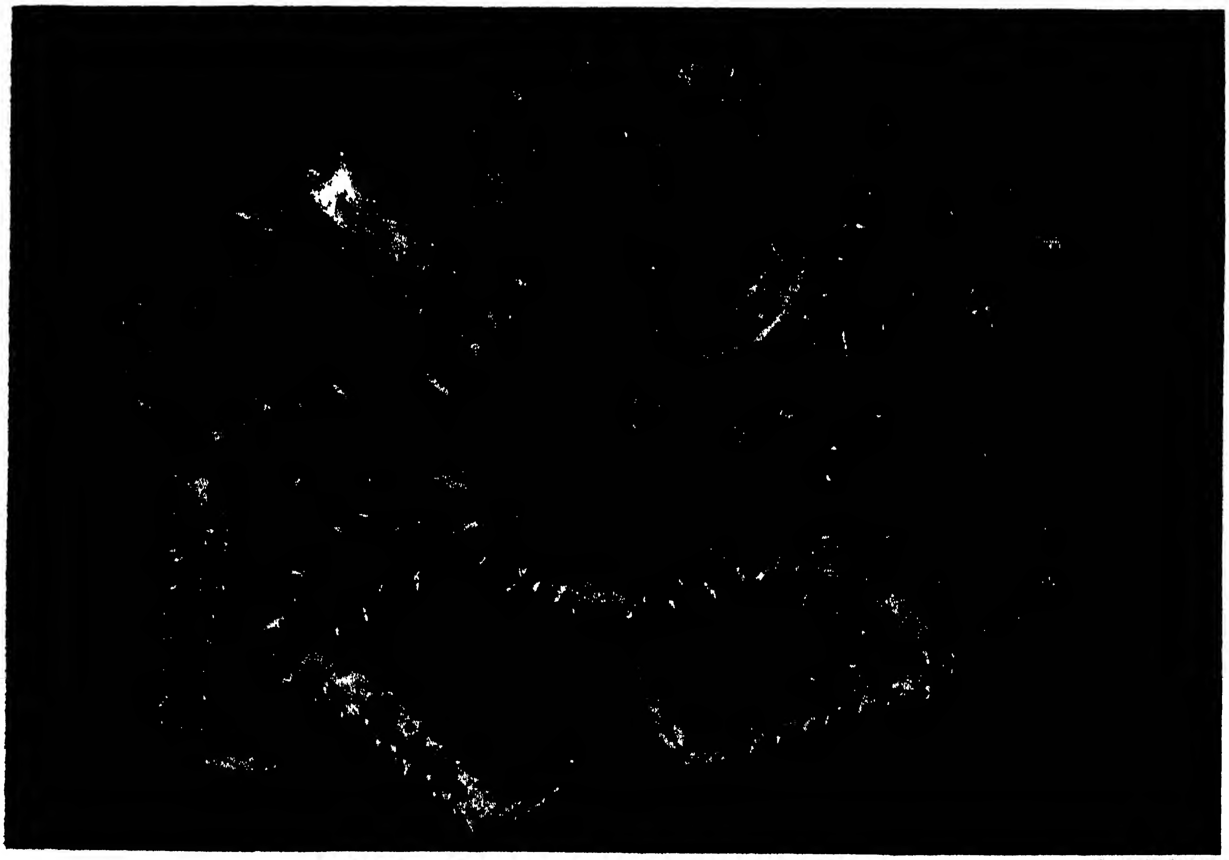
Eels, whether fresh water or marine, can hardly be considered handsome fish They are found in the

procured them the name of balloon-fish among Europeans and pillow-fish among Malays. At the same time that they swallow air and blow themselves up like the frog in the fable, they also erect their spines and deepen the brilliant coloration with which they are provided. This combination of circumstances, giving them a truly repulsive appearance, is naturally a protective measure.

But the real nightmares of the sea are the sharks, the smaller species of which are dogfish. There are a large number of kinds and they are found in all the seas of the world, some living near the bottom —the ground sharks—and others near the surface. Even when removed from their natural element they are formidable, and not safe to approach.

Elwin R. Sanborn

HUGE JEW FISH, A NIGHTMARE OF THE DEEPS



F. Martin Duncan

STRANGE STONE CRAB AND LOATHLY OCTOPUS

Belonging to the same family as the hermit crab, the stone crab (bottom) lives entirely in the sea and is noticeable for the way in which it is covered in spines The top photograph shows the creature most dreaded of all the sea's inhabitants—the octopus It likes a lair among rocks where it can prey upon crabs, which form the greater part of its food Its saliva appears to be poisonous to the crabs and it acts very quickly. Octopi are common round the Channel Islands, where they have been known to attack bathers The eight " arms " are, in s kinds, joined by a membrane forming an umbrella like structure. The creature is a true nightmare of the sea

A large shark can easily bite through a man's body with one snap of the jaw, and this fish is the real bully of the ocean.

One of the most curious is the hammer-headed shark, which is quite common in the Indian Ocean. In rare instances stragglers are found in British waters. In this fish the front part of the head is broad and flattened and produced on either side into a lobe at the extremity of which an eye is situated. The front part of the head is consequently exactly like a hammer. It is difficult to see what use this peculiarity is to the fish.

ONE of the greatest terrors of the seas, which, at the same time, is of monstrous appearance, is the octopus. This creature is not really a fish, but a mollusc. It has been known from time immemorial, as it is frequently delineated or carved on Greek objects of art such as vases, gems, coins, and ornaments. The octopus was the model on which the story of the Lernean Hydra with its hundred heads was based, the killing of which was one of the labours of Hercules. It is also the origin of many of the marvellous stories of sea-serpents.

The octopus has eight long tentacles or arms provided with suckers. Some of the tribe have ten arms, and are quite capable of attacking the largest sea creatures. Even whales are not exempt from their attacks, as frequently whales, killed by whaling ships, have their bodies scarred all over with saucer-shaped ulcerated depressions marking the grip of the octopus.

These marine molluscs are of gigantic size. In Japanese waters they have been known to upset the boats of the native fishermen, and there are traditions of similar occurrences in the Polynesian Islands.

THE Angler family contains a larger number of sea-monsters than any other. The most bizarre fish in English seas is the angler or sea-devil. This particularly repellent fish is devoid of scales and has specially soft flesh. The head is greatly enlarged and is out of all proportion to the rest of the body. The lower jaw protrudes and is provided with several rows of formidable teeth. No other living fish has such a terrible mouth. The most remarkable feature of this fish, however, is the prolongation of the first dorsal fin ray into a long filament, detached from the rest of the fin, and provided at its extremity with a leaf-like appendage.

When the fish is at rest, partly concealed on the bottom of the sea, this tentacle and appendage look for all the world like a fishing-rod and line with bait attached. There can be little doubt that the movements of the appendage attract other fish, which directly they swim in near to investigate are snapped up in the cruel jaws of the angler. The habit of the angler is to lie dormant on the sea bottom. Its whole structure and feeble muscles prove plainly that it is no swimmer, so that in order to obtain its food it has to rely on patience and an ingenious angling device. In the case of the angler the general appearance of the body, which is provided with filaments and in some species with scattered conical tubercles, imitates the sea-bottom with its fronds of seaweed and pebbles, so that the ugliness here is not a warning appearance but an attempt at concealment.

Anglers or frog-fishes are of wide distribution as regards depth and geographical area. Our own angler is most common in the North Sea. Owing to its horrid appearance it was long regarded as unmarketable, and it is only of recent years that it has been sold in a much camouflaged condition. Incidentally the angler has come to be considered a valuable fish of late years, since its pancreas is well stocked with insulin, the most efficacious remedy for diabetes.

A deep-sea representative of this family, which like some of the deep-sea eels can swallow a fish larger than itself, is the Melanocetus, a name which literally means black sea-monster. One of these fish from the depths of the Atlantic, though only four inches long, had a fish measuring seven and a half inches in length and one inch in thickness coiled spirally in its stomach. Another ugly brute of this tribe is the Antennarius. Like the angler a feeble swimmer, it conceals itself on the bottom between corals, stones and seaweeds. It coloration is so similar to its surroundings that it is almost an impossibility to distinguish it from its environment.

To enumerate all the monstrous-looking sea fish would require a separate volume. They are found everywhere, in water fresh and salt, in the greatest depths of the oceans and in shallow coastal waters, in rivers, lakes and lagoons, in the tropics and in the Arctic and Antarctic zones.

Take, for instance, the bull-fish (*Bovichthys*) of New Zealand. Seen from above, the head of this fish has a striking resemblance to that of a bull. Even the horns are imitated by projections at the side of, but not separate from, the head of the fish. Then there is the *Pataecus*, a member of the Blenny family, named after the Phoenician deities of peculiar dwarfish shape whose images formed the figure-heads of Phoenician ships. These fish might serve as a model for a dragon.

Again there is the fish of the Amazon Valley which is named after the devil, *Satanoperca*.

THE sea-pikes (*Sphyraena*) may be grouped among the few sea-monsters which are popularly supposed to be partial to human flesh. The best-known member of this family is the Barracoota, which is much feared in the tropical seas which it inhabits. Bathers in West Indian waters must beware of this fish since it is truly formidable and a voracious type. The head is long with a protruding lower jaw armed with most formidable teeth, giving it a very ferocious aspect. It is commonly supposed to be even more dangerous and intimidating than the sharks. Not only so, but its flesh is considered to be dangerous, and people consuming it often show symptoms of poisoning.

Many bathybial or abyssal fish are characterised by their terrific appearance. Since these fish live in regions of tremendous pressure and perpetual darkness they are modified in many ways.

Chapter XV

How the Serpent Got Its Poison

By Claude E. Benson

Surely of all creatures on the face of the earth none is more detested and dreaded than the snake. Examination of the evidence shows this feeling to be unfair and unreasonable. Of the entire genus of snakes some two-thirds are entirely innocuous, and of the dangerous remainder nine out of ten will fly rather than fight, while the really aggressive venomous snakes can be numbered on one's fingers. It is a case of a mischievous minority making itself unpleasantly notorious and thus discrediting an entire class.

From this minority the great constrictors may reasonably be excluded. One may naturally fear a creature which can hang from the drawing-room balcony by its tail and pick up the dustman out of the area, but a python, although by far the more dangerous, does not arouse in most people the feeling of repulsion associated, say, with a rattlesnake.

The strength of these great serpents is enormous. If any man possessed the mere " punch " of a boa, no pugilist could stay with him in either swiftness or effectiveness. Some years ago an " amateur " in serpents, who kept a kind of snake nursery not very far from London, was toying with his pets. All at once a boa—it was not more than eight feet long—which was lying on a table, without the slightest provocation let go at him with its head. It sent him flying into a corner of the room with all the wind knocked out of him and a bruise as big as a saucer on his breast-bone. Had it struck him on the solar plexus, it would in all probability have killed him.

That was with the closed mouth. Now a constrictor's jaws, like those of almost all non-venomous snakes, are equipped with three sets of teeth—upper, lower, and palatal: one on each side of the upper jaw, one on each side of the lower jaw, one on each side of the palate; six rows in all. Some have front teeth on the upper jaw, which is insignificant ; none have front teeth on the lower jaw—no snakes have. The importance of this fact, as will presently be shown, is very great in coming to a proper understanding of our subject.

The snake's teeth are long, sharp and recurved. If a python opened its mouth like an ordinary creature, a dog for instance, and bit like an ordinary creature, the bite would be sufficiently unpleasant, but a python does not open its mouth like an ordinary creature. It quite literally opens its entire head till the jaws are in the same plane, that is, at right angles to the neck so that when it strikes every tooth tells—and the stroke is delivered with the force of a powerfully operated battering ram.

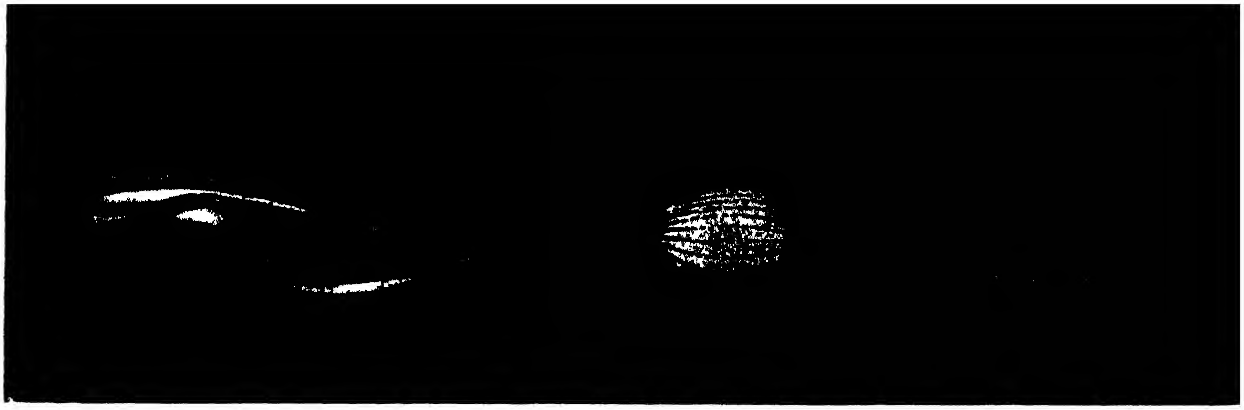
Such is the preliminary attack. The character of the decisive action may be gathered from the following incident. A man was performing at a circus in Spain with a seventeen-foot python. He had it twisted round him in the ordinary snake-charmer fashion, when something went wrong. Possibly he had forgotten to dope it by putting it in cold water and reducing it to the familiar comatose condition. Anyhow, without warning and seemingly without provocation, it drew its coils together. The man gave one shriek and dropped. The audience thought it was part of the performance. But it was not. That man's bones were found to be broken in eighty-four places.

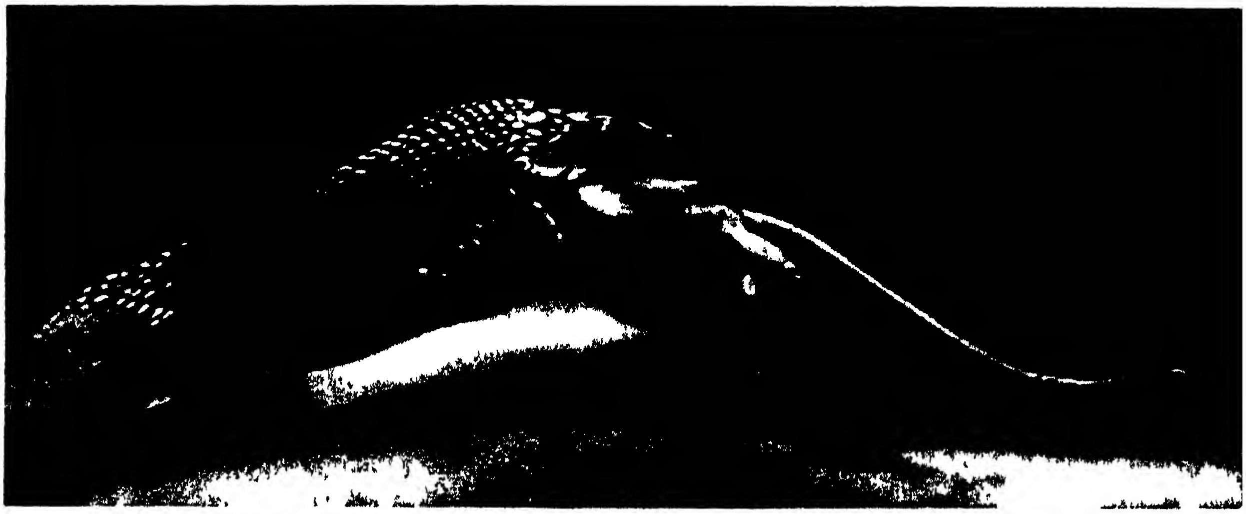
Apart from these monsters, the non-venomous snake is one of the most harmless, helpless creatures of its inches imaginable. Deaf as a post all the year round, blind as a bat at intervals covering half a year, so delicate of frame that a tap from a cane will

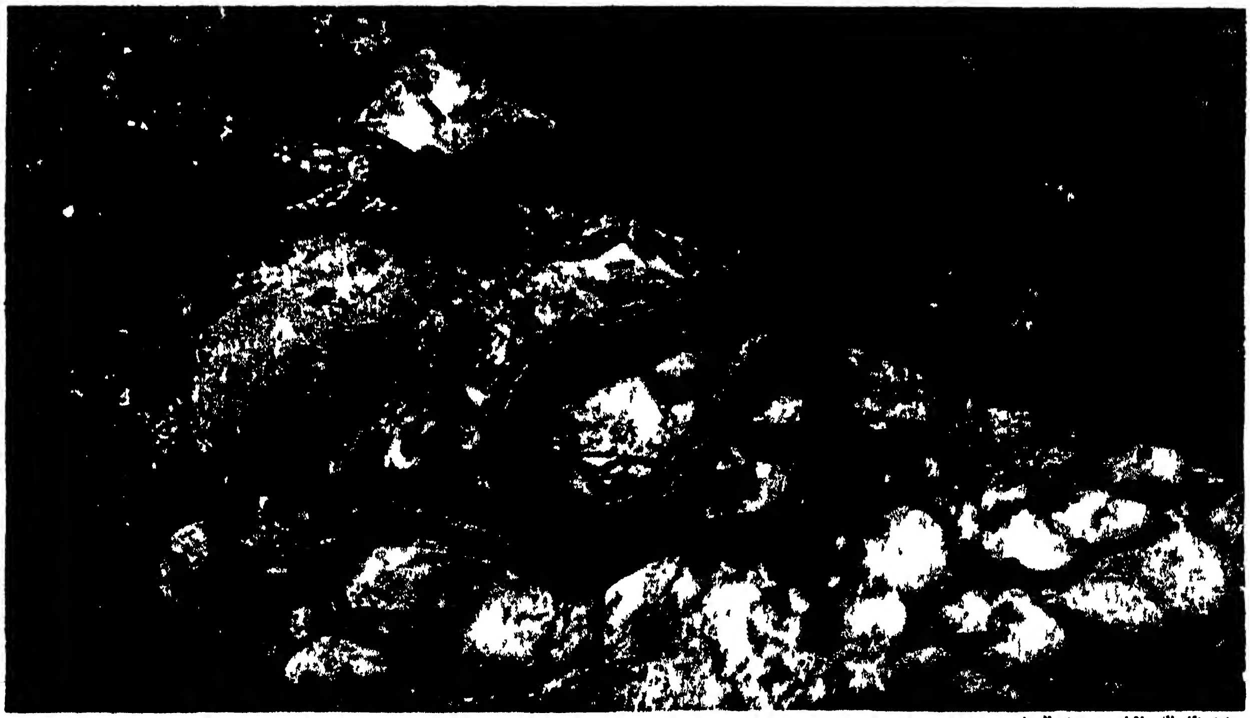
W. S. Berridge

HOUSE-HAUNTING CHICKEN SNAKE

Those who live in the southern parts of the United States often encounter the chicken snake in their houses in some localities. Its colour is dark olive-green, with brown stripes and it gets its name from a reputation for entering chicken-runs and stealing young birds.







F. W. [illegible] and Neville Kingston

WONDERFUL SWALLOWING POWERS OF SOME MEMBERS OF THE SNAKE FAMILY

Grass snakes are the most familiar of English reptiles, although in the north they are rare, and in Scotland unknown. This species, of which we have an example here (bottom photograph) may be readily distinguished by the yellow band round its neck, whence it is also called the ringed snake. It is harmless to man but, sometimes attaining a length of five feet and over, can swallow a viper, as we see. Above are a pilot snake swallowing a rat, and (top) the egg eating snake which has special growths on its spine for crushing eggs it has swallowed.

F W Bond

HOODS THAT MEAN DEATH: HAMADRYAD AND INDIAN COBRA

Cobras live in the jungle and, as a rule, avoid human beings, which is lucky since their bites have such venom that death occurs sometimes within two hours. The familiar feature of both cobra (top) and king cobra or hamadryad (bottom) is the so called 'hood' which is a temporary dilation of the skin of the neck used by the snake as a warning. When expanded the hood is supported by the front ribs which, in this part of the snake's body are specially adapted for the purpose. The hamadryad haunts ruined temples and feeds on other snakes.

HOW SNAKES CLIMB TREES

Certain snakes have become expert tree climbers, working upwards from branch to branch or taking a turn with their tail round the bole and so pushing themselves upwards. Here are a coluber (bottom) and a royal python (top)

shatter the exquisite construction of its backbone. it still holds its own in the scheme of nature. It even thrives. Sometimes indeed it becomes a kind of household pet, as, for example, the rat snake in rat-infested establishments.

ALL snakes were innocuous once. The mamba, most dreaded and deadliest of all, would have been a first-class ratter and might have been a household pet had it only retained its original virtue. How came this fall from primeval innocence? The reply entails a short excursion into comparative anatomy.

The popular distinctions between the two reptiles, the snake and the lizard, may be dismissed in two words as irrelevant. All snakes are legless. A lizard without legs, such as the so-called Glass Snake, is very uncommon. A snake has neither eyelids nor external ears. Lizards have both. The distinction is in the chin. The chin of the lizard is joined by sutures, like that of the lord of creation, in fact. A snake has no chin at all, and here the significance of absence of front teeth on the lower jaw becomes manifest. Had the snake a teeth-bearing chin-bone the amazing and unique mechanism of its head would be an utter impossibility.

For a snake can take its head practically to pieces for swallowing purposes. It has a pair of lower jaw-bones, like other creatures, but they are connected at the fore end by a ligature which is capable of extension and also of contraction. The aft end is linked up in like manner with the skull, the only solidly built part of a snake, not socketed into the jaw as in mammals. Consequently, it does not matter if the mouthful is two or three sizes too large. The snake does not accommodate the morsel to the mouth but the mouth to the morsel. Of course, it ought to choke during the operation, but it gets over that difficulty by sticking its windpipe out of the corner of its mouth and sucking in air and provender at one and the same time by different channels. Once past the gullet the food goes down comfortably enough, despite its bulk. A snake has no breast-bone and its skin will stretch to requirements.

The process of feeding, that is of getting the food down the gullet, is as follows. The prey is first seized and, once it is entangled in the six rows of recurved teeth, escape by resistance is impossible. Then one of the lower jaws is hooked in hard and drawn back as far as it will go. A similar process takes place on the other side. The prey is thus dragged back into the mouth and down into the gullet by alternate movements of the independent lower jawbones. Vipers sometimes use their great fangs to assist the process, independently and without losing a drop of poison. This last is a marvel of mechanism. The prey glides in easily enough over the recurved points of the teeth, but it cannot wriggle forward, for wriggle it does. Generally speaking it goes down alive and kicking very hard.

Now, in the case of a frog or suchlike defenceless creatures, these struggles do not interfere with the process of deglutition. It is quite a different matter

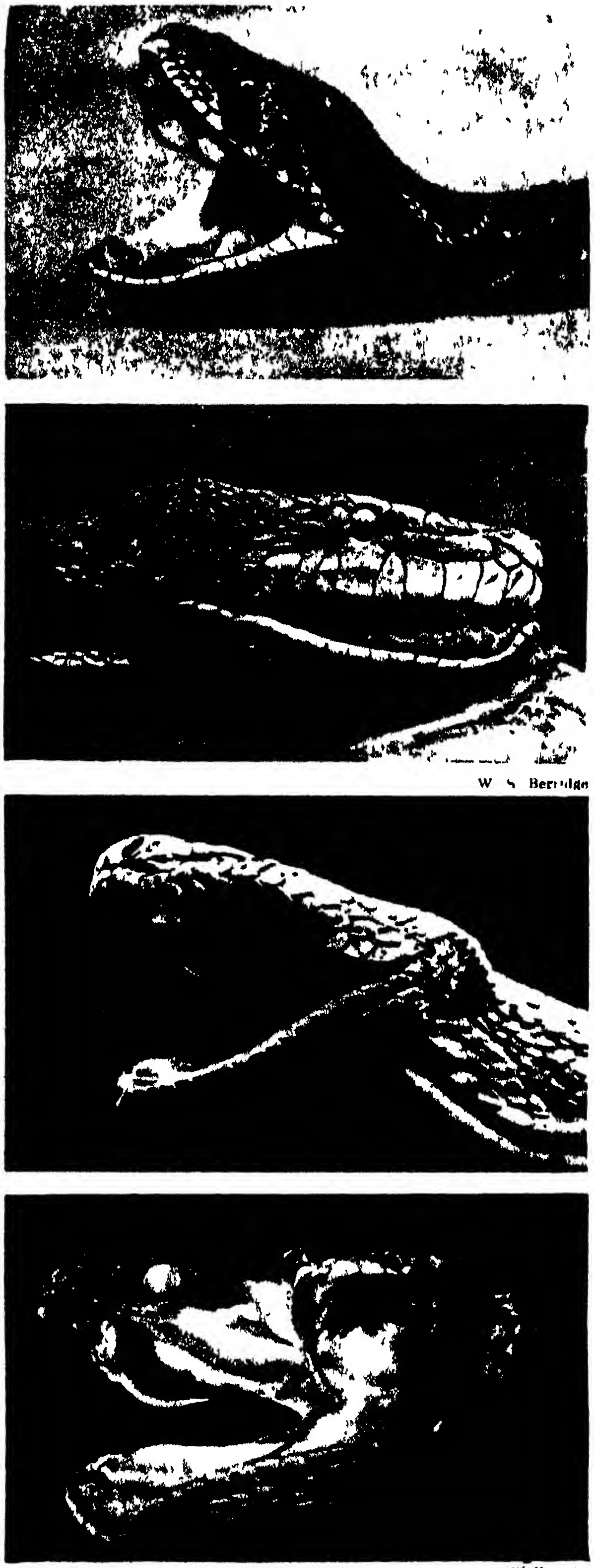
when the intended dinner is in the form of, say, a weasel. In that case the prey, like the frog, struggles to free itself but by different methods, to wit, by biting an avenue of escape out of the snake's skull. As the serpent can no more disgorge its prey than the prey can wriggle out, the upshot of such encounters is invariably a live weasel and a very dead snake.

Nature ofttimes provides safeguards for its weaklings most beautifully, for example, in the protective mimicry of the butterfly, most outrageously in the effluvium of the skunk, most appallingly in the venom of the serpent. If the mechanism of the snake's head is wonderful, the development of the poison mechanism is yet more marvellous. It must be remembered that the original object of this development was protective, to enable the snake to exist, with immunity from destruction. It became in the course of time a deadly peril to beasts and men. The process of development was on these lines.

A portion of the salivary gland, which lies behind the eye, was modified and transformed into a venom gland. From this a tube was laid along either upper jaw, terminating in a papilla in the centre of the gum. A groove was formed in the base of the eye-teeth on either side of the jaw. These are in pairs and are the front teeth. Snakes with this arrangement, unlike the constrictors alluded to, have no teeth across the front of the upper jaw. The groove, rudimentary at first, was extended in successive developments down to the tip of the fang, which also became through successive generations enormously enlarged. Round the venom gland was wound a powerful muscle which was inserted on the lower jaw, and this, when contracted, not only shuts the jaw but propels the venom along the tube and expels it by the papilla.

Such is a crude outline of the poison apparatus in the rough. The weak points are obvious. First, the snake could not close its mouth without expelling the poison and so wasting it. Secondly, there was no apparatus to ensure the poison being discharged down the groove of the fang into the wound. The first defect was remedied by a strong sphincter muscle close to the end of the duct which must be relaxed before any venom can escape, snap the snake never so viciously. It is this muscle which enables a viper to use its fangs to assist in getting its prey down without losing venom. The second defect was remedied by the fang sheath.

It must be understood that the fang, even among the less developed snakes, is a delicate instrument: in the great vipers it is very delicate, of unwieldy length and very lightly attached. If, for instance, one flicks a napkin at a viper and it strikes, a smart jerk will switch out all its functional fangs and the snake will be rendered entirely harmless. Only for a time, however. There is a reserve of fangs and the foremost of these are moved forward to take the place of those dislodged, a movement which is cunningly aided by the healing of the gum over the wound left by the accidental displacement.



W S Berridge

Neville Kingston

SNAKE HEADS AND POISON FANGS

From the bottom upwards these photographs show the severed head of a rattlesnake with the skin removed to reveal the poisoning equipment; a rattlesnake's head as seen in life; the head of a reticulated python and the jaws of a puff adder.

Berridge

WHIPSNAKE THAT STRIKES FROM AN AMBUSH IN A TREE

Matching perfectly the foliage amidst which it lurks the whipsnake kills its prey—bird or lizard—by making one or two coils round a branch with its tail and striking, the great length of its body giving it a formidable range of action. On the ground the whipsnake is awkward in its movements but in a tree its very thin and elongated body moves with alarming rapidity

That these delicate weapons should be protected by a sheath, in the same way as a sword, is perhaps not so very remarkable. That the sheath should be formed by a prolongation of the gum is perhaps almost to be expected. What, however, is extraordinary is that this sheath when wrinkled up should form a shield which deflects the expelled venom right down into the open base of the fangs. Some of the venom always does escape. Buckland, the naturalist, nearly met his death through a drop of this free venom which he imagined had circulated through the body of a rat.

In Africa there is a horrid cobra, the ringhals, which invariably spits at you, although it has fangs and can use them. Moreover, it also invariably spits in your eye, which is disastrous for the sight.

This, then, is the combination. The snake strikes and the fang pierces. Here we have a slight wound which might be dangerous, even fatal, for there is generally a certain amount of stale venom remaining in the fang-groove, but this is not all. To discharge the venom the snake must snap its lower jaw, thus driving the fang home, and simultaneously contract the venom gland and expel the venom through the papilla whence it is deflected into the open base of the fangs, down the groove therein, out at the point, and into the uttermost part of the wound. When a healthy, deadly snake thus bites home, the chances of recovery are remote indeed. Most of the cures that are effected are for mere scratches or half-bites. The remote ancestors of this dangerous family were content with quite small venom fangs, and retained a number of solid teeth behind them to assist in the process of swallowing. The conception was to strike the prey, let the venom do its paralysing work, and then, as soon as all danger of reprisal was over, to banquet.

To ensure escape from retaliation, it was desirable to get the head out of danger as quickly as possible. Consequently the most specialised snake will switch back its head the moment the blow has been delivered. It looks ridiculous to see a big rattler jerk back its head after having struck a guinea pig, but it is a very interesting example of atavism and an illustration of the why of the swift recovery after the stroke. When angry, a venomous snake will sometimes hold on like a bulldog. There is a historic example recorded in the last chapter of the Acts of the Apostles. That snake was a sand natter, which has a bad reputation for temper.

In the process of time the functional fangs were enlarged, the solid teeth behind discarded, and the tooth-bearing bone shortened. At the same time a short, insignificant bone, between the inner end of the tooth-bearing bone and the skull, was prolonged till in highly specialised snakes, such as the cobra, it now occupies two-thirds of the length of the upper jaw. A convenient name for this is the transverse bone. Naturally in the process most, sometimes all, of the solid teeth on the upper jaw were discarded so that the highly specialised venomous snake now possesses only four rows of solid teeth, those on each side of the palate and of the lower jaw, those on the upper jaw being supplanted by the deadly poison fangs.

The reason for these structural alterations was that the fang had grown too big for the mouth. It became essential to impart a certain amount of mobility to the fang-bearing bone, so that the fang might lie quietly back normally and be erected when needed for action. This bone was therefore shortened and modified and to the inner end of each transverse bone a muscle was attached. This muscle was then brought forward and fastened off in the centre of the front of the palate. It looks very much like a bowstring at full stretch, and when contracted it pulls the transverse bone forward. The front end of the transverse bone then presses against the fang-bearing bone, causing it to revolve partially, thus erecting the fang all ready for use.

W. S. Berridge

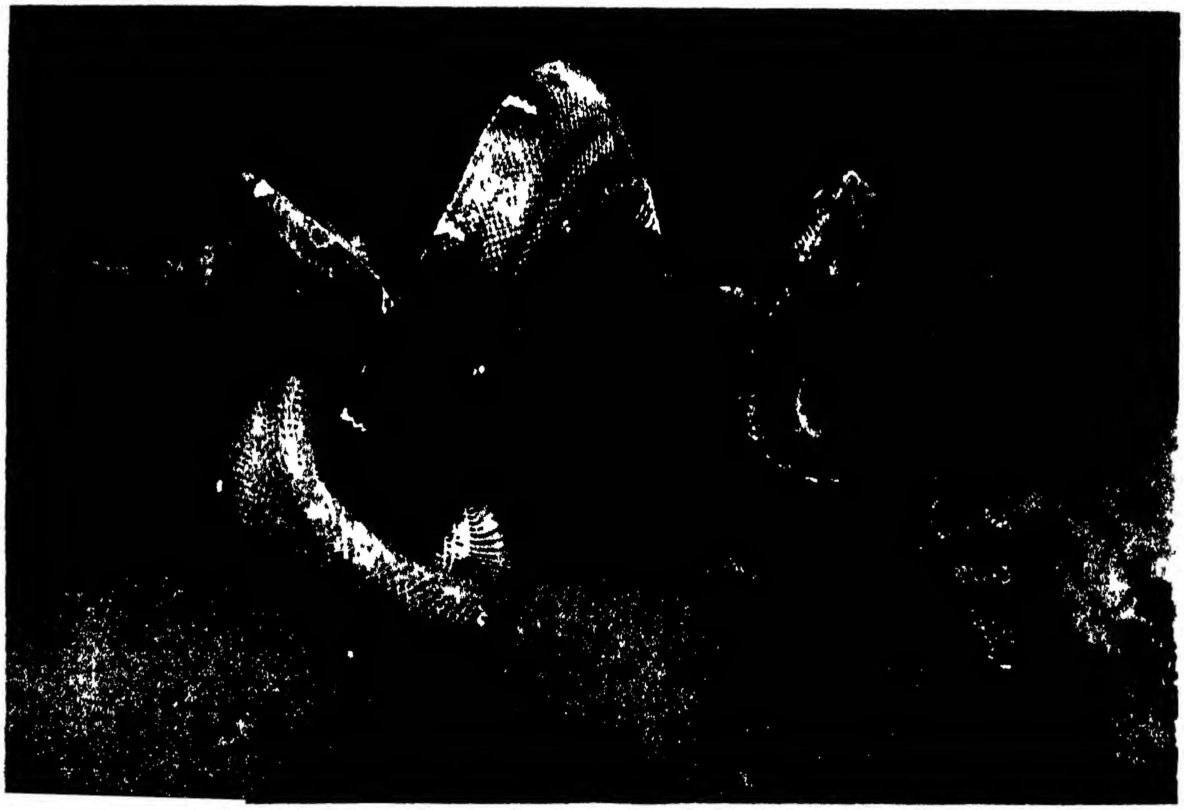
BLACK CRIBO OF SOUTH AMERICA AND THE BURROWING BOA

Belonging to the same family as the moon-snake is the cribo (bottom) one of a genus containing about seventeen species found in South America and as far north as Mexico. Many are venomous, but Cribo never attacks man, and is only active at night. In the upper photograph is a burrowing boa or shielded eryx found in Northern Africa and Southern and Central Asia. When hungry this serpent will crawl down crannies in the rocks in search of prey and will also burrow in the sand, and from this characteristic it gets its name.

Natural History, N.Y.

ANACONDA, GREATEST OF THE SERPENTS, BY THE BANKS OF THE AMAZON

Ten yards is a fearsome length for a snake, but a full-grown anaconda sometimes exceeds even that. It is non-poisonous, nor indeed has it any reason to rely on venom. Its teeth decrease in size from the front of the formidable jaws to the back, and when striking, its jaws are opened so wide as to be at right angles to its body. The power in the blow it can give is enormous, but even more deadly are its powers of strangulation. The anaconda is native to the dense Amazon forests where it spends much of its time more or less immersed in water.



F W Bond

BOA WHICH HAS LEARNT TO STRANGLE INSTEAD OF POISON

Confined to South America save for one species, which is found in the great island of Madagascar the boa is, like the anaconda, a snake which kills by crushing its victims within its coils It feeds on the smaller mammals, from rats to the lesser kinds of deer, and hunts by night Its range is from Venezuela to well within the Argentine There are a number of species of which we see here the boa constrictor (top), which may attain a length of twelve feet, and has a skin handsomely marked in yellow and brown, and (below) the tree boa

Natural History, New York

BRIGHTLY-MARKED COPPERHEAD POSSESSED OF DEADLY VENOM

One of the deadliest of snakes in North America is the copperhead, which is widely distributed throughout the United States save in the northern parts. The whole body is a beautiful copper colour with the head lighter than the rest. Its average length is about three feet, and it is found in the tall grass near water and feeds on mice and birds. The jaws have a particularly wide gape. Another name for the copperhead is moccasin snake, and part of its deadliness lies in the fact that it strikes without any warning.

Such, in brief, is the wonderful story of the evolution of the venom fang of the poisonous elapines, of which the best-known representative is the cobra. The cobra possesses a pair of large fangs on either side of the jaw, and two or three faintly grooved teeth behind them. In the most highly specialised of these snakes, the coral and the mamba, only the fangs remain.

THE vipers started from the other end of the jaw—that is, from the back. The earlier specimens are known as the back-fanged snakes. Here, again, the gradual development can be clearly traced from an insignificant little fang close against the gullet, which could not conceivably begin to operate till the prey was half-swallowed, to a formidable array of big fangs behind the eye. Then there comes a hiatus, an unfilled gap between the back-fanged snakes and the vipers.

These last boast only a pair of venom fangs a side on a very short bone. All the rest of the upper jaw is occupied by the toothless transverse bone. An examination of the fang-bearing bone is illuminating. What has happened is clear. As the elapines discarded all their solid teeth behind the fangs, so the vipers have discarded not only all the solid teeth in front of the fangs, but most of the jawbone with them, and, with this section of the jawbone, all the fangs but a pair on each side.

The fang mobility achieved by this arrangement is amazing; the sweep of the point from rest to action passes through a quarter of a circle. The fangs themselves normally lie back along the palate, and the mouth has to be opened wide to permit of their erection. There is no difficulty about this, for the viper, like the python, opens its head till the jaws are in the same plane, the fangs being incidentally erected till they are at right angles to the jaw. But what about closing the mouth with a snap? Must not the fangs drive through the lower jaw? It has been observed that the ligature of the chin can be contracted, and the viper, when it misses a stroke, contracts its chin so that the fangs slide back outside to be tucked away comfortably later on.

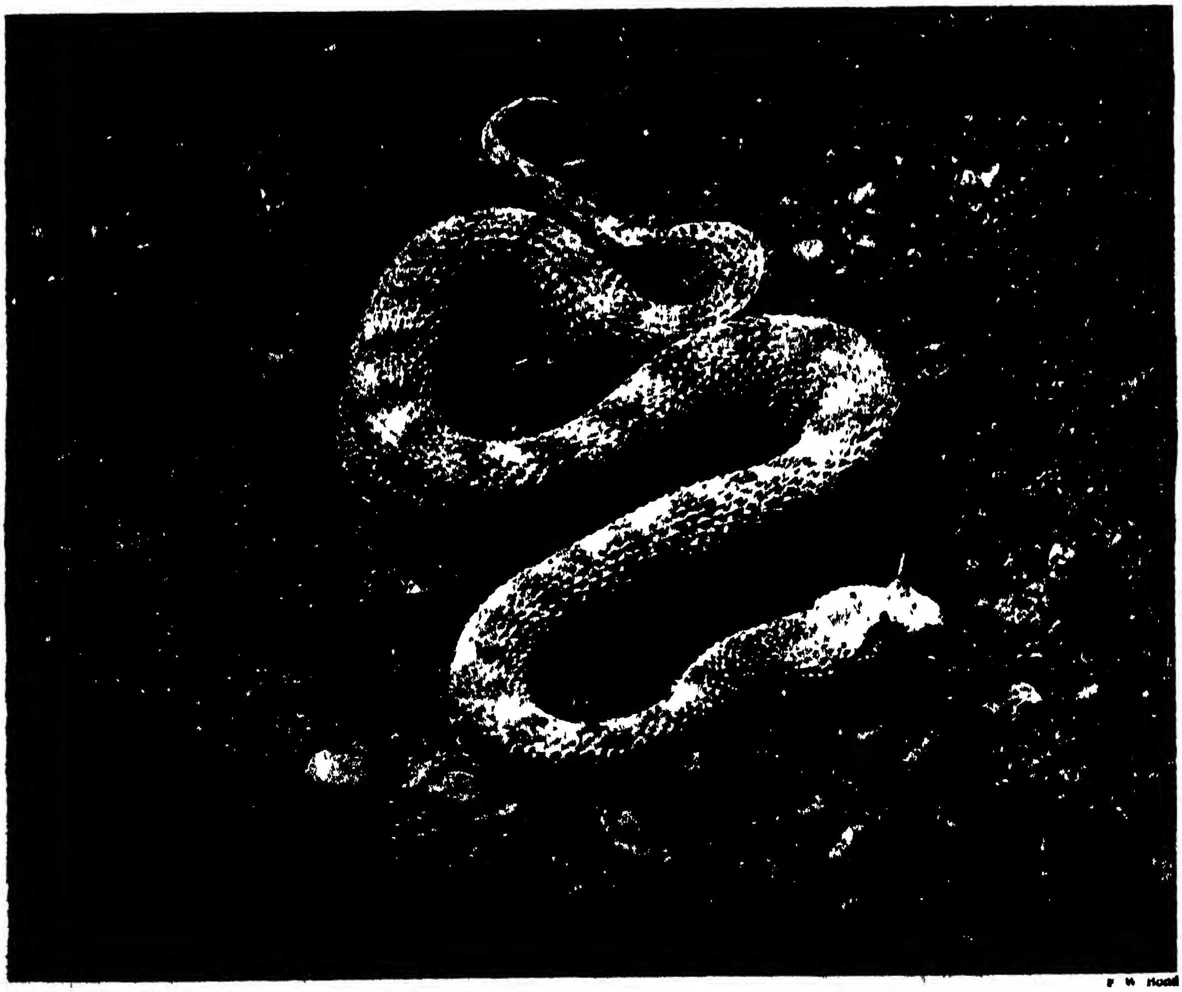
It is frequently stated that the snake has hollow or perforated fangs. As a matter of fact, it has not, although the mistake is quite a pardonable one. What has happened is this. A groove was, as has been noted, formed in the base of the solid tooth to act as a channel for the venom. This groove was afterwards extended down the entire length of the fang, but still a great deal of venom escaped between the edges. To remedy this the edges began to fold over towards each other, gradually narrowing the channel of issue—in the cobra they are about a hair's breadth apart—till they finally coalesced as in the case of the mamba, the coral, and all the vipers. At first sight it looks as if the fang had been drilled down the centre, but on examination, the line of juncture can be detected even with the naked eye. A section of a fang is interesting. It shows the process of incurvation quite clearly; and it is seen that the curved outer coating of dentine surrounding the venom channel encloses a semi-circle of pulp.

We read of snakes springing at people. A snake can no more jump off the ground than a horsehair cushion. The most it can do is to raise the fore third of its body. The typical cobra does so, and its stroke is forward and downward after the manner of a cut. Now, inasmuch as to make the bite absolutely

effective the cobra must close its jaws as the fangs go home, it is clear that the stroke must be relatively ineffective along a considerable portion of the line. If one places one's elbow on the table with the hand loosely open and the palm down, and then slaps one's palm on the table, the danger-points will be just where the fingers naturally straighten themselves and just before the finish.

The viper strikes, as a rule, from coil, after the manner of a thrust, and is rather more likely to get home. On the other hand, the toxic properties of cobra venom are more active than those of viperine, and so the balance is evened up. It is interesting to note that viper venom is practically identical with, though more powerful than, that of the back-fanged snakes, thus establishing the connexion between the two which has sometimes been questioned owing to the hiatus in the transition process. Were it not that sundry visitors to the Zoo still speak of a snake's tongue as the "sting," it would seem unnecessary to state that the tongue's chief use is that of a feeler. Consider what all this means. It means that the once harmless snake, in order to be able to secure its prey with immunity, has, in a period unknown, developed an apparatus whereby paralysing venom can be sent direct to its mark with the least possible waste, that it has evolved most efficient weapons for this purpose, weapons which can be quickly and automatically replaced in case of loss or injury, weapons which it keeps protected in a sheath when not in action, and that it has constructed a most delicate mechanism for the elevation and retraction of the fangs, both of which actions take place within the time occupied by the snapping of the jaws.

Nothing has been said here about sea snakes, but it may be mentioned in conclusion that whereas the venom of the mamba paralyses warm blooded mammals, that of the venomous sea snake, a horrid creature with a head not much bigger than a thumb, paralyses cold-blooded fishes.



F. W. Hood

ASP, OR HORNED VIPER, A TERROR OF THE SANDS

Cleopatra, it will be remembered, met her death—as the story goes—by the bite of an asp which she had procured for the purpose. There are two species of this deadly little snake, one in the Sahara and the other in Egypt, and both lie half buried in the sand awaiting their prey. The bite is very deadly and seems to be frequently administered entirely without provocation. The horned viper has the power of rubbing its coils together when excited, so that the friction on the scales causes a rustling noise.

Neville Kingston

PLAYTIME AT THE ZOO: POLAR BEARS IN HIGH SPIRITS

When the polar bears become playful, they collect a crowd as quickly as any animals in the Zoo. No doubt the fact that their gambols are amphibian is largely responsible for the size of the audience. There are special windows cut in the concrete wall near the bottom of their swimming pool and one can peer through the green murk and see dim white forms whirl past, or an inquisitive snout come right up to the glass. Wrestling and mutual ducking (bottom) are favourite games, and sometimes a lucky bear gets a ball to play with.

Chapter XVI

Playtime Among the Birds and Beasts

By W. P. Pycraft

Author of "The Infancy of Animals"

On the subject of the play of animals we really know very little. And this is partly because we neglect the many opportunities presented to us of carefully watching animals in their natural state. Since we shoot them, and hunt them on every possible occasion, it is not to be wondered at that they flee from us at sight. That this behaviour has been instilled into them by painful experience is shown by the fact that when explorers have landed on islands uninhabited by man, or among the vast penguin colonies of the Antarctic, neither beast nor bird showed any fear.

Now and again some lover of nature will contrive to lie in concealment in the known haunts of some particular species and patiently wait till, believing the dreaded enemy to be far away, a whole family party will perhaps creep forth from their hiding-place and resume the occupation suddenly broken by the intruder who means no harm. Most people, surely, have read Charles Kingsley's delightful description of young otters at play in his Water Babies. But how many even of those who hunt otters regularly have ever seen the like ?

What is the origin, and the meaning of this "play" ? And at what stage in the evolution of animal life does it make its first appearance ? We may be fairly certain that play has no place among the lowly protozoa, nor among the fixed sea-anemones—for play means movement. But we may be tempted to regard the aerial evolutions of may-flies and midges as a form of play. As I write, myriads of these minute flies, or "midges," are dancing in the sunlight all around me. And a few moments ago, in the room I have just left, a half-dozen of the small species of house-fly known as "fannia," were gyrating madly in wide circles in the centre of the room, every now and then twisting and turning around one another with incredible speed, as though performing some favourite waltz ! None of these performers was feeding, nor were they searching for food. May we not suppose, then, that they were animated by the sheer "joy of living" ? They were, in short, "playing."

Yet it is curious that only some winged insects, and these are all adults, be it noted, display this most desirable emotion. The bees, for example, have no playtime ; ceaseless labour is theirs, save only in the case of the drones among the hive-bees. The dance of the fireflies at night seems to be a form of play. Yet there are few other beetles which give themselves up to such frivolity. Among the Invertebrates, in short, play seems to be an impulse possessed only by some insects. One can hardly imagine a playful slug ; nor are crabs or starfish likely to disport themselves in this way !

Among the Vertebrates we find the first apparent evidence of play in the fishes. The mad flights of the flying-fish are generally attributed to frenzied efforts to escape capture by under-water pursuers. But since the performers commonly cross one another's tracks in all directions, it would seem that on such occasions they are merely "playing." And here, we have play with a "meaning." They are "practising" for more serious moments; for their strange "wings" have undoubtedly been evolved to enable them to escape under-water pursuit. If there be fishes that play one would expect to find similar cases among the frogs, toads, and newts, since they are higher in the scale of life ; but no such cases have ever been recorded, nor do we find any among the reptiles.

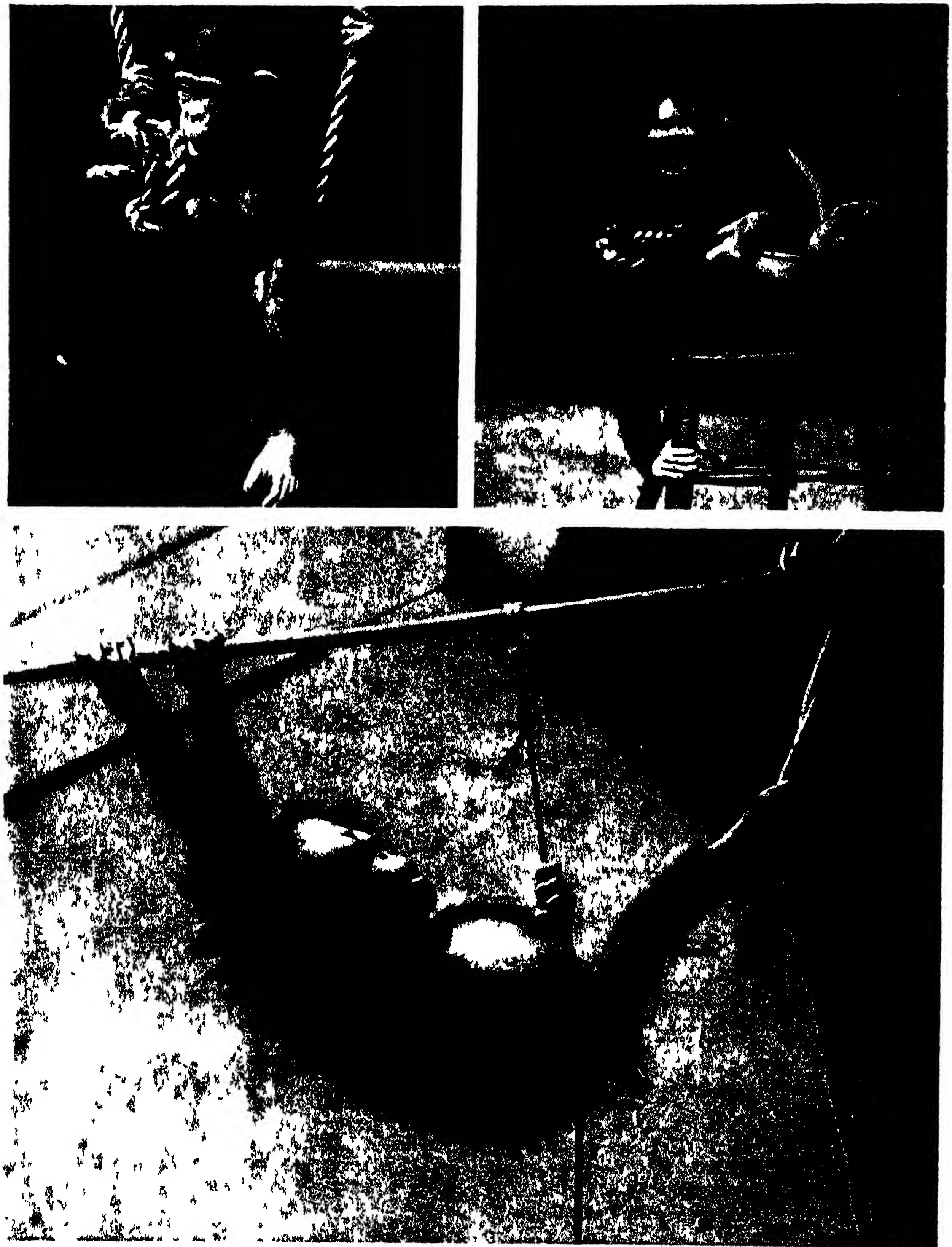
I can imagine some of my readers remarking that newts, at any rate, "play," and so do water-tortoises, crocodiles, and lizards : quite so. But this brings me to a quite important phase of my argument. We must distinguish between different kinds of play ; expressing different impulses, or emotions. There is the play of the midges and house-flies to which I have already alluded. The performers here are staid adults ; and their gyrations seem to be pointless ; at most a mere expression of physical fitness, yielding, doubtless, at least a vague sense of pleasure. And there is the play of young animals, which has a very definite meaning, as I hope to show. Finally, there is a whole series of complex forms of "play" commonly associated with sexual maturity, and described as "courtship" displays.

Reference has just been made to "staid adults" among the insects whose play is apparently meaningless. But among the higher animals we find innumerable cases of adult play which has no reference to "love-displays."

Those who have taken long sea-voyages must often have watched the play of porpoises and dolphins round the ship. This, at any rate, seems to be the most reasonable interpretation of their gambollings, and the huge humpback and other whales have been seen leaping out of the water and falling with a resounding splash with an abandon which suggests nothing else than an expression of pent-up vigour that must find an outlet.

Animals in captivity, if they be not too closely confined, display no less animation. Monkeys at the Zoo, for example, are particularly playful. And I remember watching, some years ago, two polar bears at play. The game was, apparently, to push one another into the swimming pool. The successful one then leaped in after his playmate when there began a tussle, each apparently trying to push the other under water. As soon as one or the other succeeded in making his escape there began a wild race round the edge of the pool and the jostling began again !

The play of a cat with a mouse is of another kind. The rough and tumble scrimmages of monkeys and



F W Bond

"MONKEY TRICKS!" A MERRY TRIO OF ORANG UTAN AND TWO CHIMPANZEES

While the orang utan (bottom) swings from the steel supports of the roof of his cage with solemn enjoyment, a neighbour chimpanzee finds enough puzzles in a mandoline to keep him amused almost indefinitely The other chimpanzee (top left) is sitting in what is really the remains of a trapeze The wooden [illegible] has been wrenched out of place by mischief making hands, and the ropes thoroughly well entangled Almost any time is playtime among the monkeys and all but the largest apes

"KING OF THE CASTLE" AND BEGGING GAMES PLAYED IN CAPTIVITY

Certain games are common to the young of animals and man, and a kind of "king of the castle" with a basket for the castle was often played at the London Zoological Gardens by a certain tiger cub and his lion cub friend. The defence and attack are obviously being carried out with spirit. In the lower or bear section of the Mappin Terraces the begging antics displayed are always a "good draw." In the upper photograph there is a polar bear with a brown bear making belief to beg on the concrete edge of the trench which takes the place of bars.

Neville Kingston

TWO DIFFERENT WAYS IN WHICH ANIMALS PLAY DEMONSTRATED BY A YOUNG TIGER AND A BEAR

There seem to be two distinct kinds of play among the animals. The more usual is the game involving the practice and perfection of some feat which is useful in their ordinary life or, in the case of caged animals, of what would be useful in their wild state. But some animals do really play, sometimes, for the fun of the thing. The young tiger playing with his keeper is really performing, in a very mild way, the same evolutions as it would if the man had attacked it in real earnest. To have even a young tiger's paw drawn across the face must take some getting used to. The Indian bear, on the other hand, which is trifling with a piece of ice, is obviously not practising anything but just amusing himself and, incidentally, ourselves as well.

Neville Kingston

THE EARLIEST PLAYTIME OF ALL: ZEBRA COLT WITH ITS MOTHER

If an animal is going to play, its first games and practical jokes will be with its mother. Watch a kitten being washed as an illustration But an example of this fact very seldom seen is shown splendidly here where we have a young zebra upon its hind legs to bite and jostle its parent with the invincible high spirits of the young animal which as yet has no care even in captivity. Wild animals seem fierce enough to human beings and so the patience often shown by the adult under much juvenile troubling appears the more interesting.

bears and the racing exploits of porpoises may probably be regarded as physical exercises, taken, albeit unconsciously, to " keep fit " ; and one may, perhaps, regard the play of the cat with a mouse as an instinctive effort to keep in practice. All the cat tribe behave after this fashion, for they have to effect their captures by a stealthy approach and a sudden spring demanding quickness of eye and stroke. The dog tribe chase their prey and kill it as soon as it has been run down. They have, therefore, no incentive to defer the killing.

But we all know how much a dog likes to chase a ball which he will bring back time after time to be thrown again. Dogs love to simulate anger at any attempt to rob them of what, for the moment, is their " prey." I have in mind a small terrier belonging to my daughter. Bonzo loved to seize on a piece of stick, lay it at her feet, and invite her to throw it away. Any attempt to take it from him after its " capture " was met by fierce snarls and growls, as he held the precious capture between his teeth. But these " angry " sounds were but make-believe, for presently he would release his hold and stand expectantly to have it once more thrown into the air! Here, be it noted, is behaviour reminiscent of the wild dog. Generations of domestication have not quelled these primal instincts.

Many forms of play have their roots, so to speak, in behaviour which domestication has almost deprived of meaning, and certainly of usefulness. Thus horses when feeling particularly " skittish," will rear up on their hind legs and strike out with their fore-feet, and will then presently turn and kick with their hind feet. Since these are now shod broken legs may result, but in the original wild horse this probably very rarely happened.

And now let us turn to the play of young animals. This is not merely the sign of boisterous good health, nor is it purposeless. It is also worth noting that only some kinds of young animals play, and among these that play is in the nature of coming events which cast their shadows before. It is a preparation for

Neville Kingston

CONTORTIONS OF THE BABY LEOPARD WHEN REALLY EXCITED

Cats of all kinds are the champions at twisting and squirming, and the kitten, when worked up, goes through the most extraordinary contortions. Just so the baby leopard will roll on its back, tearing madly with all its claws, then leap up and wildly paw the air. This photograph caught it in mid career, captured a split second's worth of the lithe savagery of its movement and gives it to us here in all its natural extravagance of gesture and unrestrainable fierceness of expression.

crises in after life; for activities which, unless they be efficiently performed, will lead to an early death.

Caterpillars, which we sometimes forget are young butterflies, or moths, do not play. The whole of this stage of their existence has to be spent in long bouts of feeding, broken by fasts as the successive moults are due. Indeed, there is no evidence of play taking place among any of the invertebrates while immature.

But watch a kitten at play. Its "games" have reference to mouse-catching. Sometimes it will be noticed that kittens throw themselves down on their sides and tear imaginary victims with their hind feet, whereby we may see how larger victims than mice are rent to pieces. Puppies and fox-cubs play at fighting, and thereby, though unconsciously, gain skill for real combats which will be inevitable later.

YOUNG sheep and goats play at butting one another, as well as leaping. This is true not merely of wild species, but even of our own farm animals. They will never need the skill this early training gives, but it is interesting to note that they retain the instincts of their wild ancestors in undiminished force.

One might go on multiplying instances of this kind, but enough has been said to bring home the fact that "play" in young animals is no meaningless activity but a most interesting and instructive foreshadowing of events wherein only the efficient survive.

And now we must turn to another very remarkable series of activities commonly regarded as so many forms of "play," but which have no counterpart, no preliminary forecasts, in the immature stages.

These refer to what are called "courtship" displays. If such be "play," then it is play of a very different kind from that so far described. For "play," so far as we have discussed it, is a form of "make-believe," but the instances now to be considered have a direct and immensely important object—the continuation of the race.

Maturity, in so far as the animal world is concerned, in only gradually attained, and most animals become sexually mature before they are fully developed.

When sexual maturity is arrived at, certain glands, and especially the reproductive glands, discharge substances known as "hormones," which effect profound changes in behaviour, in addition to their functions in regard to reproduction, and the development of what are known as the "secondary sexual characters." But it will be easier to interpret this behaviour after a few typical examples have been given. Let it suffice to say, for the moment, that "courtship displays" are found only where the two sexes are represented by two individuals leading a free, separate existence, though even here conjugation may be effected without a "display." The butterflies and moths, for example, make no "courtship displays," but are drawn together by scent, which is generally diffused by the female, and can be detected by the male over great distances. But this by the way. Displays of the kind now to be discussed are to be found in creatures as low in the scale of life as spiders, and scorpions, and end only with Man.

LET me cite first the most astounding story of the spider's courtship. To begin with, he first spins a silken web and thereon discharges the all-important spermatozoa. He then draws up this fertilizing fluid into his hollow palps, and then approaches the female with fear and trepidation, as well he may; for unless he keep all his wits about him he will be promptly seized, and eaten! No two species behave in the same manner at this critical time, but one which I have in mind, *Saitis pulex*—it has, unfortunately, no name in common speech—approaches the female of his choice, walking as delicately as Agag, till within a few inches of her; then, lowering the legs of one side, till his body is tilted over towards her, he moves in a semicircle before her, then reverses the movement in the opposite direction, gradually getting nearer. She now makes a dash towards him, but he, fearful, raises his two front legs as if to ward her off, and retreats backwards. Again and again these movements are repeated, till at last he whirls madly round and round her, and she too starts whirling in a giddy maze. There is a halt, and all begins over again. Then she slowly moves under him and the mating is accomplished! Unless he can instantly escape he will be eaten!

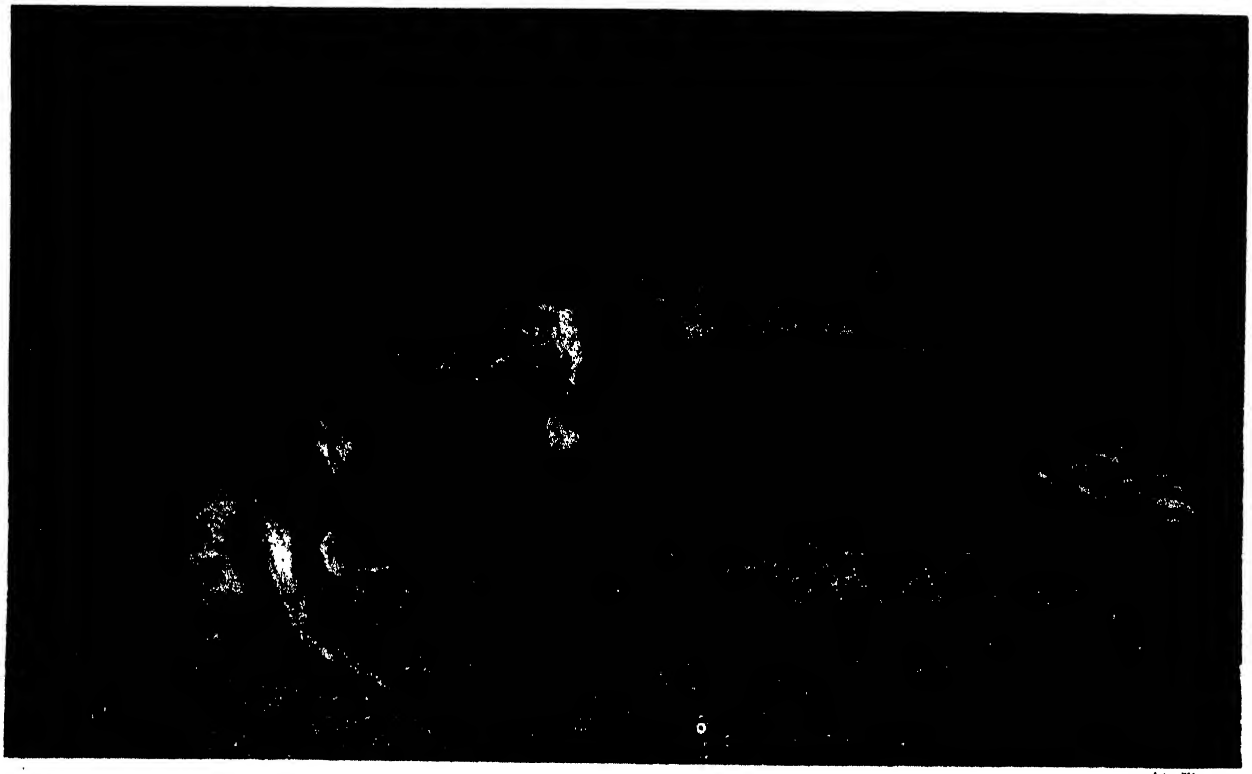
Under the fever of love even the dull and apathetic crocodile will execute most undignified caperings in the presence of his mate. He will twist and turn, or rather twirl, on the surface of his chosen pool, with head and tail raised high in air, and his capacious barrel of a body swollen out to bursting-point. These antics are performed to the accompaniment of bellowings and roars heard at no other season of the year. But more than this, an appeal is also made to the nose, as well as to the eyes of his apathetic mate, for during all this parade of his amorous feelings he exudes from glands in the lower jaw and tail an overpowering odour of musk. At last his protestations have their reward, but the point to be noticed is that the emotions of the female are only to be aroused by an immense expenditure of energy on the part of the male.

These "love-displays" attain to a wonderful variety among the birds. That strange species the frigate-bird, for instance, has a very striking form of love-play. Under the beak is an inflatable scarlet bag. During his moments of amorous excitement this is distended till it looks like a great scarlet balloon. A dozen males may sit together on the branch of a tree overhanging the sea, with their air-sacs thus inflated. As soon as a female approaches they utter a strange cry, like wow-wow-wow-wow, and then clatter their beaks like so many castanets. Some will then fly out over the sea and prepare for another display!

Neville Kingston

A TOY TO BEGUILE THE SCORPION'S SPARE TIME

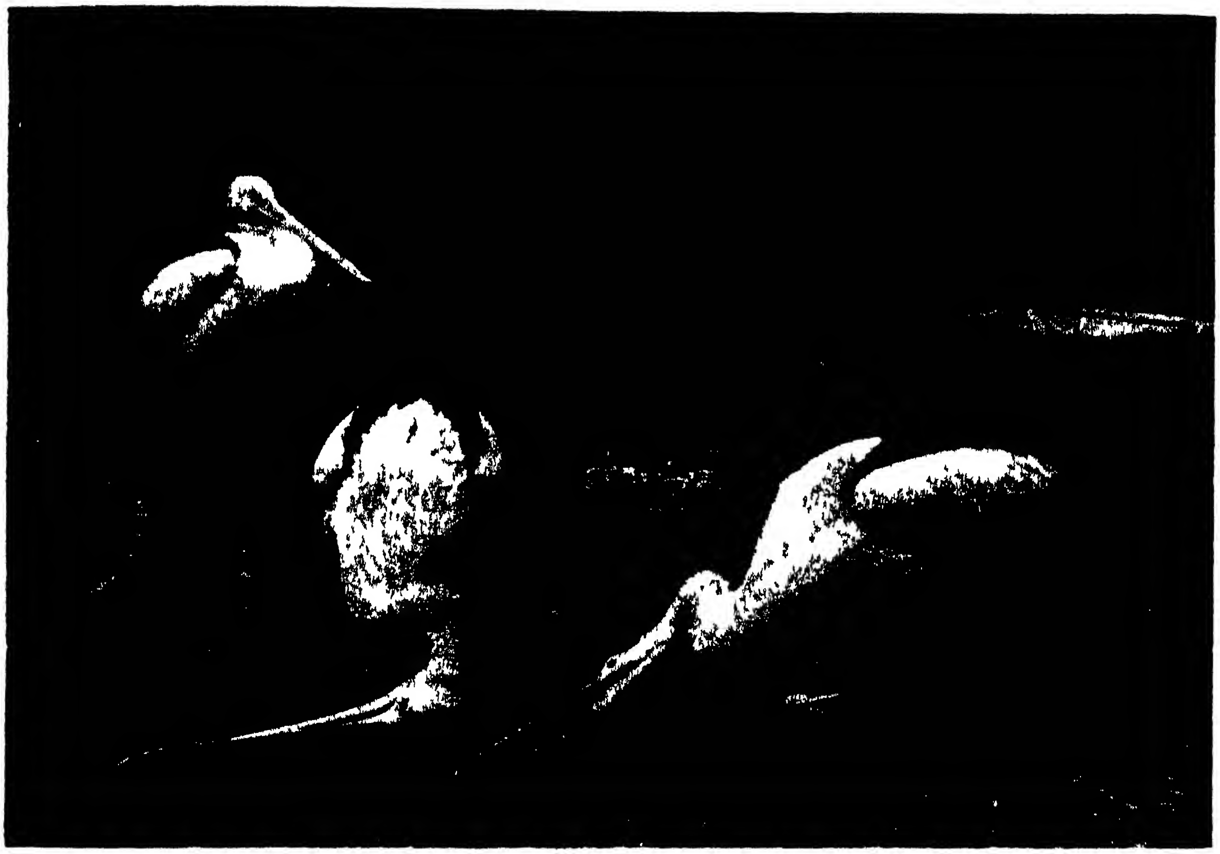
It would not occur to everyone that the scorpion might like something to play with during its leisure. But an indiarubber mouse seems to have provided some diversion to this particular one, even if its actions were not very "playful" to look at. We see it in the act of pretending to kill the mouse. It will, presumably, never be known whether this was a game so far as the scorpion was concerned or whether it merely disliked the indiarubber mouse. At any rate, the spectators had plenty of harmless fun.



Neville Kingston

THE HORNBILL FINDS A NEW PLAYMATE AND DANCES IN TRIUMPH

Africa and India are the dwelling-places of the hornbill, but although so far from home, the bird is light-hearted enough in its cage. In the wild state it spends most of its time on the ground, and is but a slow, unwieldy flier, so that it does not miss the freedom of the sky as so many of the larger birds seem to do who must sit ever with eager wings folded. Below one of these birds is examining an indiarubber frog, and above we see it, filled with the joy of life, executing a kind of hornbill hornpipe.



Neville Kingston

PENGUIN AND PELICANS IN PLAYFUL MOOD

The same indiarubber frog that was lent to the hornbill seen in another page was tried on the penguin as a toy (bottom) and placed in front of a piece of fish. The first thing the penguin did was to remove the food out of his new playmate's reach The pelicans (top) always provide amusement whether in a frisky mood or not as they waddle about in their pen Here we see two of them performing some strange antics with their long bills and evidently enjoying a game that two can play at,

Nymph at pond bottom

After about eleven months

It climbs a plant

Splits its skin

Begins to emerge

It rests for a little

Releases its tail

Five minutes later

The wings are stretched

They are dried

The perfect insect

MARVELLOUS METAMORPHOSIS OF THE DRAGON-FLY FROM THE SWIMMING GRUB TO THE BEAUTY OF THE AIR

During the long process of change which the dragon-fly grub undergoes there is no resting as in the case of the caterpillar. The grub or nymph, as we see it in the extreme top left photograph, lives a life of continuous activity at the bottom of its pond, preying on other water insects. This it does by seizing its victim in a massive and powerful pair of jaws which convey the food to the mandibles. The nymph is also provided with a special means of locomotion, consisting of an apparatus for sucking water into the body and then expelling it, so that the reaction drives the creature forward. About twelve months are spent in the water, and then the nymph climbs up a plant, its skin splits and the flying insect emerges to its life in the sunshine. Photographs by J. J Ward.

Chapter XVII

The Amazing Round of Insect Life

By Edward Step, F.L.S.

Author of "Marvels of Insect Life"

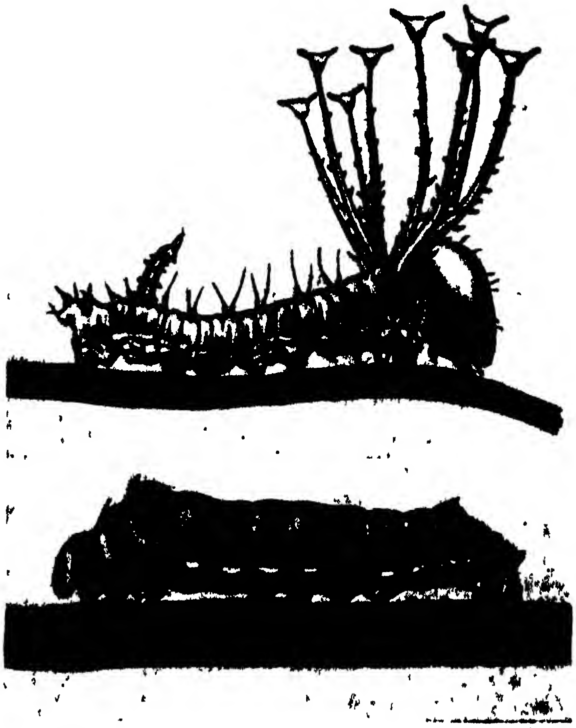
When we consider that the insects are at once the most numerous in kinds and the most extravagantly fertile of all land animals (some fishes are more prolific), it is astonishing that through the ages man has learned so little about them.

Of a few we have discovered a trifle, knowledge forced on us often owing to their power of causing us personal annoyance, or by their utilising our food supplies for their own sustenance; and from this very imperfect information we judge and condemn the entire race. We make an exception in the case of the honey-bee, because we are able to rob it of the fruits of its industry. We also welcome the ladybird to our gardens, not only because it is brightly coloured, but we have read that it helps to keep down the greenfly pest. Certain flies and bugs assist in that work, but seldom receive recognition or thanks from the gardener. The female glow-worm, too, is sacrosanct because of her mystic light more than as an acknowledgment of her destruction of snails. Few of us know it as a beetle; and if we met with it in the daytime, when the luminosity is switched off, its fate would be that of other "creepy-crawly things."

How these creatures in summer become suddenly so abundant as to force themselves upon the attention of the least observant is still to most of us a mystery. Their prevalence is accomplished in a variety of ways and at diverse stages in the life of the insects in question, which know in some subtle fashion when it is the time for activity. In some form or other they have been with us through the leafless, flowerless months, and know more of probable weather changes than does the Air Ministry. The parent insect may lay a batch of eggs in autumn, and these will remain until the appropriate food plant is active, when the eggs hatch and the young larvae begin feeding; or the gravid female may pass the winter in secure retirement, coming out in spring to deposit her eggs on the new leaves. In other cases it is the larvae, hatched in autumn, that hibernate, resuming their active feeding in spring, more frequently the winter is passed in the chrysalis stage, a method that enables the perfect insect to emerge with freshness in spring, mate, and produce a new generation.

But for some of the insects that we see here in summer the winter climate of Britain is, usually, too severe for their survival in any stage; and for the following year's representatives of these species we are indebted to the enterprise of female immigrants from the Continent that have flown the Channel or the North Sea; these lay their eggs here in early summer. Without these reinforcements we should have to remove the Large Garden White, the Painted Lady and the Clouded Yellow butterflies from the list of British butterflies.

The Painted Lady is a notorious migrant in many parts of the world; and in most years enormous swarms of it leave its headquarters in North Africa for other countries. Our own share of these reaches us in successive waves in May and June, sometimes again in September. These lay their eggs on our thistles, and from the eggs are developed the home-grown butterflies we see when autumn comes.



L. H. Jusel

WEIRDEST OF CATERPILLARS

Caterpillars are extremely vulnerable as they lie on or crawl about plants. Some species, such as S sphinx molina, shown here in two stages (the top one magnified), have developed growths like tentacles presumably to terrify attackers.

The common course of butterfly development, under the name of the "metamorphosis of insects," is one of the elementary lessons in natural history, but the details are often forgotten and need restating. The egg—variable in shape, and often beautifully decorated with symmetrical patterns in relief—hatches, and a minute caterpillar emerges and begins to attack the green food proper for its kind, which it finds ready to hand. Some, by way of appetiser, begin by consuming the egg-shell.

Throughout the caterpillar stage the insect feeds almost continuously, growing rapidly and, in consequence, needing to cast its distended skin about five times, each day consuming food equal to many times its own weight. The caterpillars of most butterflies complete their growth in

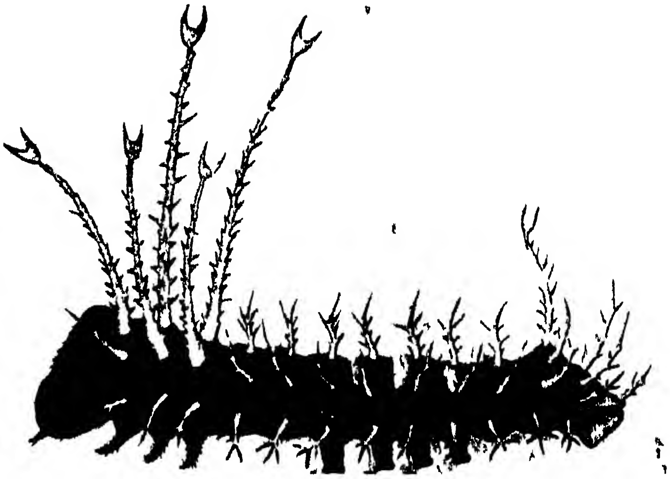
A. Hyatt Verrill

FEEDING AND RESTING POSITIONS OF THE EVER-HUNGRY CATERPILLAR OF CITHERONIA REGALIS

There is no hint in the appearance of this strange-looking creature that it will eventually turn into the moth which we see on the opposite page. The caterpillar of Citheronia Regalis, seen here in its actual size, is rather alarming when viewed at such close quarters. In the left photograph it is in its feeding position with hungry jaws fastened to a leaf. On the right is the same caterpillar in the position it adopts just before beginning its change into a chrysalis. Notice the strange plume-like appendages on the head apparently calculated to repel even a hungry enemy.

This giant caterpillar is found along the eastern sea-board of America. Notice that in feeding it hangs upright but that just before becoming a chrysalis, it hangs head downwards.

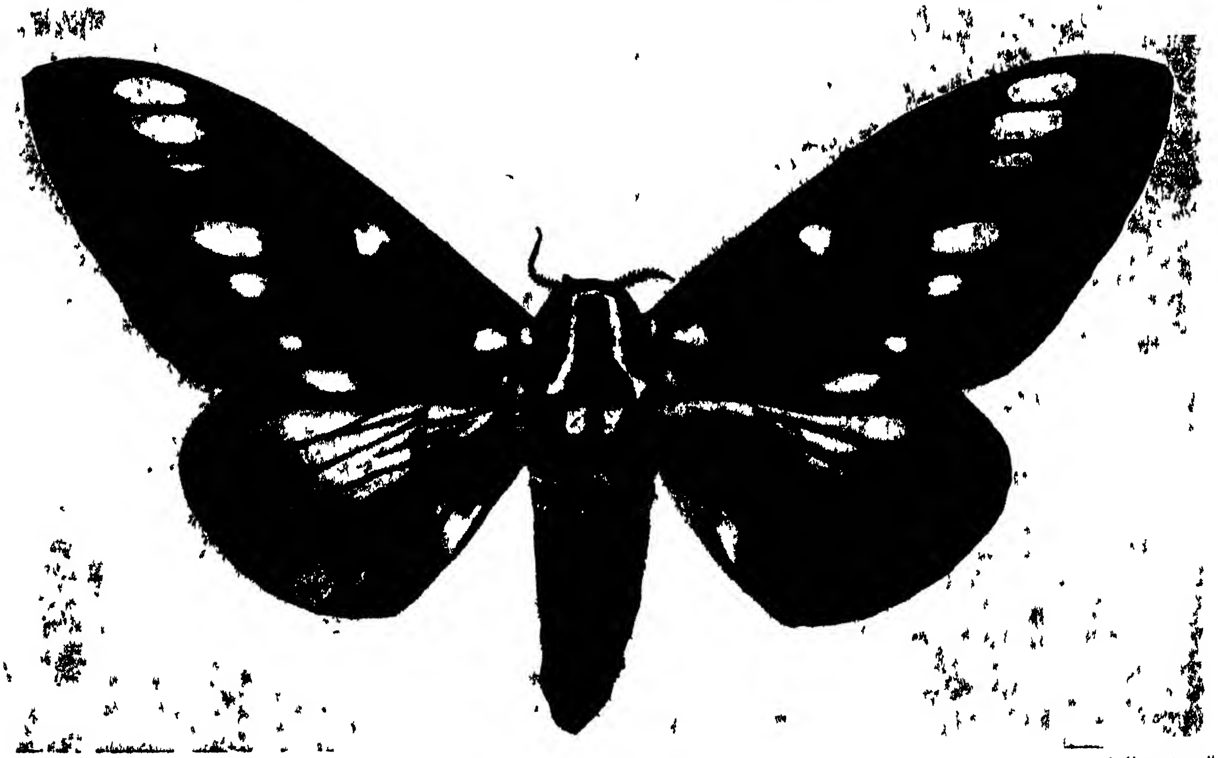
Pupa and cast larval skin



Freshly hatched caterpillar, magnified

Pupa, natural size

Full grown caterpillar, natural size

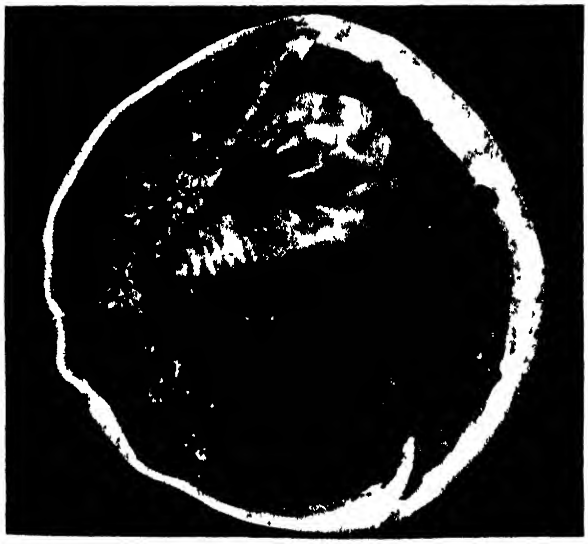


A Hyatt Verrill

The male moth, natural size

STAGES IN THE STRANGE TRANSFORMING OF CATERPILLAR INTO MOTH

Many caterpillars make their first meal upon the remains of the egg from which they have hatched They find themselves already deposited on the plant or tree which is suited for their food, and so can settle down at once to eating Quickly the growth goes on, necessitating a series of new skins, each skin splitting and revealing the caterpillar in a new one Finally a kind of varnish is exuded which hardens into the outer shell of the chrysalis whence the perfect moth will emerge so utterly different The photographs show the moth Citheronia regalis



H. Bastin

DESTRUCTIVE GRUB OF THE PEA-WEEVIL

While many of the beetle family do much good work, there are certain nefarious members, among them the pea-weevil. The lower photograph shows the grub as it lives and feeds on its host. Above is the creature into which it eventually turns.

a couple of months; those of the goat and leopard moths, feeding in the wood of living trees, spread the process over several years. When the requisite amount of reserve material has been accumulated the caterpillar throws off its skin once more, but this time a different form is disclosed.

What we see now is the undeveloped butterfly or moth, showing the form of its wings, legs and antennae covered by a protective coating of varnish. The internal organs of the caterpillar have been broken down into a semi-fluid condition, from which the organs of the adult insect must be built up on a different plan. The caterpillar jaws that had been fitted for cutting up vegetable solids would be of no use to the butterfly, which feeds by sucking nectar from flowers, so a tubular mouth has to be constructed with a suitable digestive apparatus. In addition to the rebuilding of the legs from the small five-jointed feet of the caterpillar, the four large wings with their covering of innumerable microscopic scales have to be evolved, with suitable muscles to work them, and the compound eyes have also to be developed. More important than these, the sexual organs must be elaborated. When all these transformations have been completed the skin of the chrysalis splits and the teneral butterfly walks out and clings to the plant, remaining still until its flabby, crumpled wings have smoothed themselves and expanded, and the long legs have hardened and become usable.

From this point there is no further increase in size; growth is complete. This is a fact ever in need of remembrance, for it is a common error to regard the Small Garden White as though it were a juvenile example of the Large Garden White, and to speak of small flies as young flies. We may meet with dwarf aberrations of any insect, but if they have wings we may conclude that they are fully adult insects and will grow no more.

Though many of the butterflies and moths take nearly a year to complete their course of development, reckoning from the time the egg was laid until the emergence of the perfect insect, of others there may be two or more generations in the same period; on the other hand, many moths whose caterpillars are internal feeders in shrubs or trees, require two or three years for the completion of their cycle. The duration of life differs greatly in the very varied forms of insect life: the greenfly or aphis may begin and end its course in a few weeks; at the other extreme we have the seventeen-year cicada of the United States whose normal span of life is from thirteen to seventeen years, the whole period spent underground feeding upon roots and developing its wings before it makes its first appearance above ground. The eggs are not laid in the ground, but in slits of tree branches, the young nymphs on hatching at once seeking the earth, burrowing to the depth of a foot or more. The generations overlap and some are in evidence most summers, but at the end of the maximum period they appear in great numbers.

In most of the insects exhibiting a very marked difference of form in the several stages (which has given origin to the term "insect metamorphosis") the principal feeding for the building up of the adult is effected in the caterpillar or larval stage. Arrived at full growth and the final change of skin, insects of this class take little if any food; it is not the clothes-moth that destroys our silk and woollen fabrics, but its caterpillar. A striking departure from this rule is seen in the gnats, to be referred to later. Bees and wasps that are so industrious in the gathering of food, do this work mainly in order to lay up stores for the sustenance of their helpless young. Many beetles, however, are fairly voracious in their winged, or perfect, state.

On the other hand, there are families of insects, such as the dragonflies, earwigs, cockroaches, grasshoppers, and bugs, in which the course of development goes on smoothly from the hatching of the egg to the perfect state without any abrupt changes of form such as we have described. Changes take place, but they are so gradual that there is no cessation of feeding or activity. The food is the same at maturity as it was in infancy: so no change in the character of the mouth-parts or the digestive organs is needed, whilst the development of wings and sexual organs is spread over a comparatively long period.

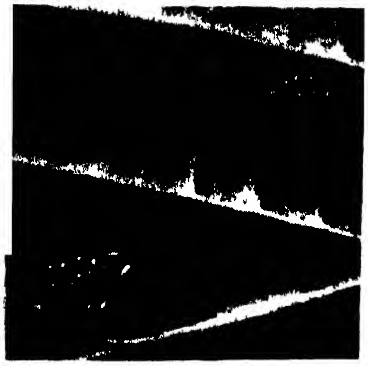
From this statement it appears that the abrupt transition from one stage to another—from larva to pupa, and from pupa to winged adult—is due to the need for a revolution in the alimentary system; but some doubt is thrown upon this by the fact that many beetles consume the same kind of food during the adult stage as they ate when grubs, yet they pass through a quiescent pupa stage as abrupt as that of the butterfly. There are, for example, the ground-beetles, active and carnivorous both as larvae and beetles; the cockchafer in its winged state continues a vegetable diet in the shape of green leaves, though its portly grub is so well stuffed with reserves after from three to five years of feeding on the roots of grass, corn or beet, that it has to lie doubled upon itself. The somewhat similar grub of the stag-beetle, that spends four years in eating decayed wood in tree-stumps, is content at maturity with the juices from crushed oak shoots. The jaws of the male of this fine beetle, enlarged to a semblance of huge antlers, are of little use beyond ornament, though it has been said that rival males fight with them; but the muscles controlling them do not appear to be powerful enough for the infliction of any considerable physical harm.

ANOTHER well-known group of beetles whose food is of the same nature in both larval and perfect stages, is that of the ladybirds; but here the diet is fellow insects and restricted to the gardener's black beast, the aphis or greenfly. From the moment of leaving the egg the grub begins to consume the greenfly, and continues the good work for about a month, killing at the rate of thirty to forty an hour. There are several overlapping generations during the summer, so that the destruction is continuous. If on a given patch of infested vegetation the clean-up has been finished before the current batch of ladybird larvae is full-fed, they resort to cannibalism: the strongest eating the weak in order that a sufficient number may become beetles and hibernate to ensure the continuance of the race next year. The survivors pass the winter in some snug retreat, where at times they associate in vast numbers. We have disturbed such sleepy assemblies, numbering many hundreds, under the loose bark of a dead tree. It is said that in the Rocky Mountains such retreats are hunted for, and the beetles collected and housed through the winter, so that in spring they become active a fortnight or so earlier than they would do out of doors. They are then distributed to the fruit-growers, who can set them out in batches on their trees before the "blight" has had time to increase greatly. One species has been introduced from Australia to California in numbers because of its destruction of the scale insects that attack oranges and their kind.

Among those insects that are predaceous throughout life and that do not undergo any abrupt changes or pass through a period of quiescence, are the splendid dragonflies, of which the larger species afford the finest examples of wing-power. Before they reach the winged stage they spend a year or more crawling over the bottom of ponds or streams, or climbing the stems of aquatic plants in pursuit of prey. This consists of other water-insects, worms, the tadpoles of frog or newt, small fishes, etc. To fit it for this predaceous life, it is endowed with a set of powerful

AN OAK APPLE AND GALL WASPS

Those brown globular growths on oak twigs called oak apples are produced by the gall wasps. They puncture a young shoot and lay their egg (top), and when the gall or "apple" forms round it (bottom) a grub hatches out, which later becomes a tiny wasp


Eggs on leaf


Larva


Two pupae


Beetle just emerged


Fully developed


Wing cases opened

PICTURED LIFE-STORY OF THE SMALL BEETLE CALLED THE LADYBIRD

A ladybird is about the only kind of beetle which the ordinary person will allow to walk about on the hand. But it is not always realized what a useful function this brightly coloured little insect performs. Its food is the greenfly, that pest of rose-trees, and but for the ladybird the greenfly would become a very serious menace indeed. Our photographs by J. J. Ward show the development of the British species, the two-spot ladybird, from the cluster of eggs laid upon a black currant leaf through the dull-coloured larva to the perfect, coloured beetle

cutting jaws, and the lower lip is extended into a long, hinged arm with a pair of sharp hooks at the broad extremity. This instrument, kept ready for immediate use folded under the creature's legs, can be shot out suddenly to capture any desirable prey, bringing it back to the dragon's jaws and holding it there until consumed. In his hind body he has an expanding chamber lined with a delicate tissue in which the blood circulates and takes up oxygen from fresh supplies of water. When he desires to cross the floor rapidly in pursuit of prey, the chamber is contracted strongly, and the water, ejected backwards with force, drives his body forwards.

THE parent dragonfly dropped her eggs into the water or laid them upon some aquatic plant, so that on hatching the larval dragon found itself under suitable conditions to begin its life of rapine. The pond, like the sea, teems with varied living forms; and it is not long before the dragon larva has grown powerful and able to secure any victim he may desire.

Midway in the dragon's career there appear two pairs of buds from his forebody above the hindmost legs, and later these reveal themselves as the tightly packed developing wings of his aerial stage. Then, one summer's day, he feels impelled to take the air, and climbs up a flag or reed and fixes the hooks of his feet securely in his support. His skin splits for the last moult, and he walks out feebly and hangs limply to the stem. In a little his four netted wings spread long and broad, his body lengthens and becomes coloured brightly, the whole integument acquires firmness, and without teaching he discovers the use of the wonderful planes that will carry him through the air at the speed of an express train. Dr. Tillyard has timed the flight of an Australian species, and found that it was at the rate of nearly sixty miles an hour. From now on, selecting a woodland ride or a stretch of hedgerow as his hunting territory, he flies swiftly back and forth, turning shortly at the end of his beat or to cope with the doubling manoeuvres of a smaller quarry, capturing and eating all other insects that may cross his path. Country folk call him "horse-stinger" and "devil's darning-needle," but he has no sting.

Daddy longlegs, the crane-fly, that becomes so conspicuous and annoying in autumn, when the wet outside or the light inside prompts it to come indoors, and indulge in absurd antics, is from its size a convenient example of the vast fly family—the insects that have only one pair of developed wings. The second pair has been reduced to tiny knobs at the end of slender stalks, difficult to see in most flies unless searched for, but in daddy quite obvious.

The female daddy-longlegs may be seen walking over grassland, where her very long legs are a help rather than the encumbrance they appear to be. Now and again she sinks between the grass-blades and bending her hind body at right angles she digs the pointed end into the soil. In every shaft sunk she deposits one of her numerous black eggs; and as they are all deposited singly and apart she has to traverse a considerable area in order to dispose of them all. From these, in spring, hatch out the dirty-looking, cylindrical, footless grubs, which are known to the agriculturist and the gardener as the destructive and hated "leather-jackets."

The mission of this grub is to keep down the too rapid increase of grasses and other plants by eating their roots, often cutting them across the collar, so that the green parts wither and die. The rooks and starlings know the sign and descend upon these yellow patches, probing the lawns and meadows with their sharp beaks to get at the succulent grubs. Those that escape this fate, in due time become elongated chrysalids, with the future wings showing plainly in their wrappings and the body ringed at every joint with stiff bristles. These permit them to wriggle forward when they have exhausted one grass-tuft, and are used in autumn in order to push the fore-parts of the chrysalis above the surface. In badly infested grassland, about October, large numbers of these strange objects may be seen sticking vertically out of the ground, their oddity increased by a pair of curved, horn-like processes standing out behind the head-parts. These are hollow, and admit air to the developing daddy. Soon, the chrysalis skin splits at the top, and the adult fly emerges gradually, and hangs out its long legs and wings to straighten and become firm for use in the new aerial life.

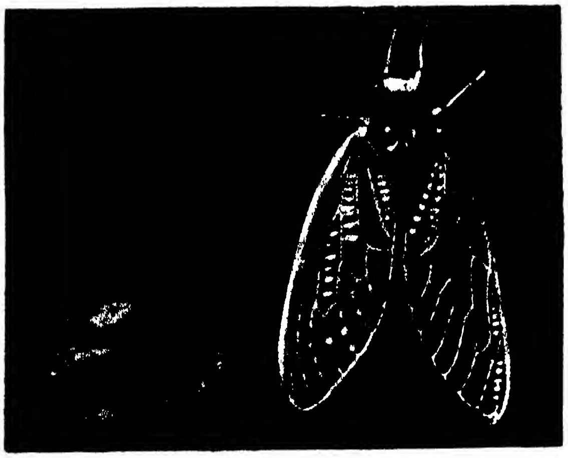
DADDY'S progress through life is not typical of all the two-winged flies. Their number in distinct species is enormous: so we find that they are very varied in their life-histories. The gnats and mosquitoes spend their early life in water, the big-headed, long-bodied grub floating inverted, breathing through a siphon that is thrust up into the air, what time the other end of the larva is capturing microscopic food.

Perfect insect emerging

The cicada with wings partly expanded

Wings fully expanded

Wings spread to show their structure



Two hours after emergence

THE CICADA FULFILS ITSELF IN THE SUNSHINE AFTER SEVENTEEN YEARS UNDER THE GROUND

Cicada eggs are laid in the stems of plants, and six weeks later these eggs hatch and the emerging larvae fall to the ground and quickly bury themselves. It is seventeen years before they see the light of day again. This time is spent in feeding on plant juice extracted from roots and in gradual growth. All this preparation reaches its climax exactly seventeen summers after, and the larvae emerge from the ground and crawl up the tree or plant stems. There the wonderful transformation illustrated by these photographs takes place Photos by Ned J Burns

When the chrysalis stage is reached, the future gnat resembles a miniature tadpole, with breathing-tubes (now from the head) pushed through the surface film of the water. The new-born perfect gnat issuing from the chrysalis skin as it floats on the water, has to balance itself very carefully or it would be drowned on the threshold of its winged career. As a rule the female is the only bloodsucker, and she seems to require to be distended with mammalian blood before she can lay her eggs. Among the gnats or mosquitoes are species that are the agents in the spreading of many terrible diseases. Some of the aquatic grubs take in among their food microscopic forms of life that require to be swallowed in order that they may be transferred later to the blood of higher animals when the perfect insect taps their veins. This blood-sucking of the females is the means by which dengue, malaria, elephantiasis, yellow fever and other troubles are spread.

Some of the insects that are more intimate attendants on the bodies of uncleanly people, such as bugs, fleas and lice, are also the carriers of germs which set up disease in the human subject, and sometimes animals of a higher order play a part. Thus a specialised flea that infests rats and other small mammals carries the bacillus of bubonic plague, and when that flea indulges in human blood it passes the germs into the system of its victim. Trench-fever during the War was caused by the excreta of the body-louse; which also carries typhus. Typhoid germs are carried freely by the feet and tongue of the house-fly, which can leave them on our food and so ensure their admission to our bodies. Sleeping-sickness is spread by the tsetse flies of Africa.

E. Step

INSECTS WHICH MADE THE GIFT OF SILK TO MANKIND

There are a number of moths whose caterpillars spin silk casings or cocoons to cover themselves when in the chrysalis stage, but only the silkworm proper produces just the right quality for making the thread. Above we have the three stages of caterpillar, chrysalis surrounded by the silk cocoon containing about 1,500 feet of silk, and the emerged moth. Nature invented the cocoon for the moth, but man has subordinated the moth to the cocoon with the result that the moth has degenerated and lost the power of flight.

Chapter XVIII

The Beauty Parade Among the Birds

By H. J. Massingham

Author of "Dogs, Birds and Others"

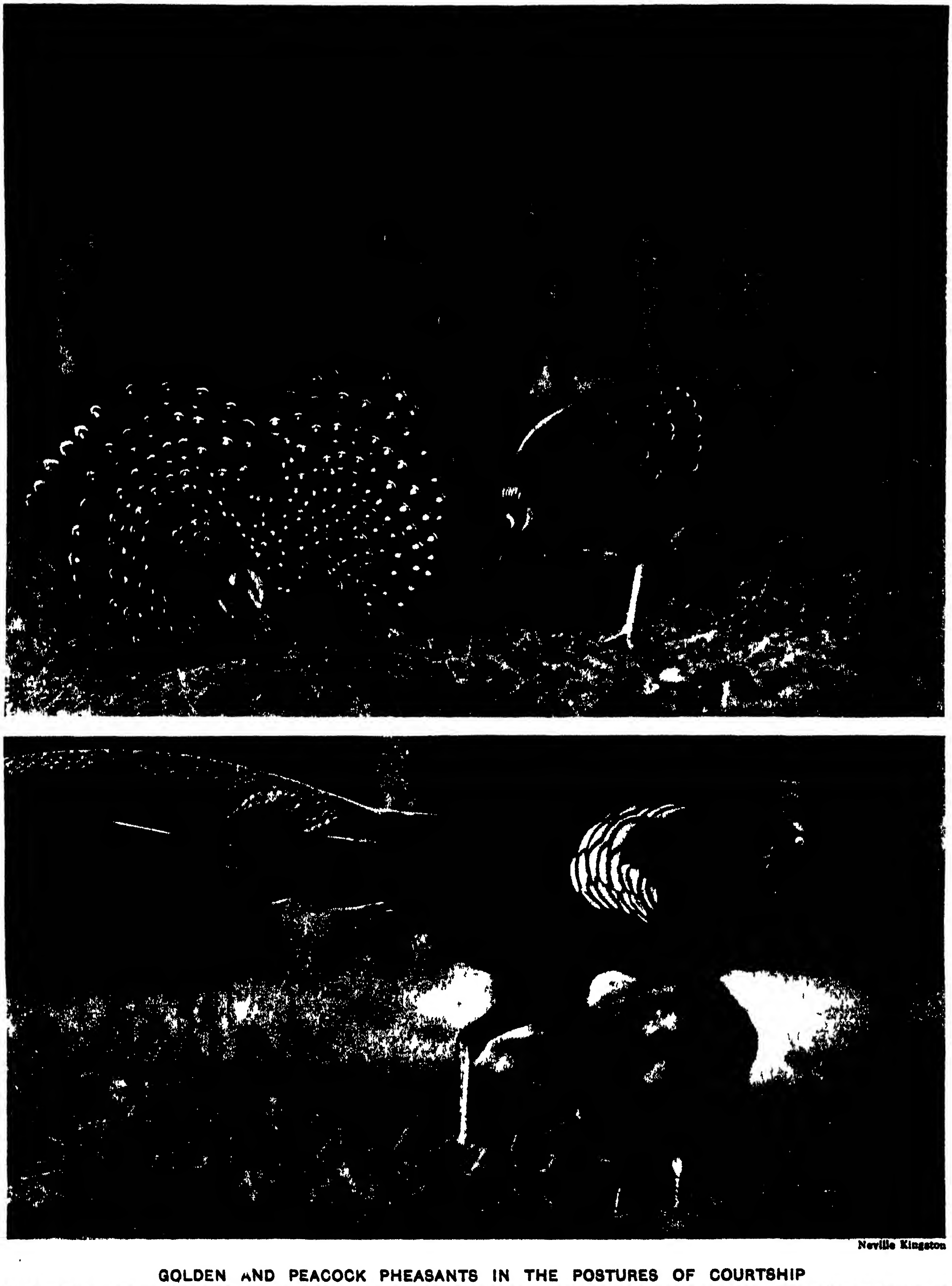
THERE is no subject more delightful in itself, more significant for increasing our knowledge of life and its true values, and more involved in obscurity, prejudice, and rule-of-thumb ideas than the theme of bird-lovers. When the average country-lover thinks of the courtship and mating of birds, he has no alternative but to recall the theory of sexual selection as it was set like cold lard in the third quarter of the last century. Like others of our theories of what goes on in wild Nature, the Darwinians out-Darwined Darwin, and it is only of recent years that the light of experience has corrected the formulae of hypothesis. The credo of the Darwinian disciple is that birds are to be thought of as automata, each sex of which performs certain quite different functions when the biological routine of the breeding season pulls the trigger. The male is excited to a violent erotic frenzy which he expresses by "antics" and by displaying his plumage to the most decorative advantage so that he may obtain possession not of the hen-bird that he "loves" but of any female who will yield to his frantic spell-binding.

The hen-bird on her side remains completely passive to the male's advances, but at the same time (a contradiction in terms) exercises choice as to which of her competing suitors she will award the prize of herself. The theory of sexual selection then goes on to declare that she selects the gaudiest or most virile or generally attractive male with whom to mate, with the result that the second and third-raters fail to rear families. This is the story of the evolution of elaborate song and bright plumage through the elimination of the more backward and unattractive candidates.

Common sense disposes of some of these postulates, strict observation of others. If they represent a natural law, why is monogamy the prevailing custom in bird-life? For it is only among the polygamous species that a majority of brilliant males court a minority of plain and unresponsive females. Everybody knows how the birds-of-paradise vibrate and expand their dazzling plumes as they jig along the boughs before the drab, indifferent hens; how the blackcock assemble in "leks," a sort of bare arena where the males tread a measure in a tranced ecstasy and the prosaic grey hens turn their backs upon them, pecking about within the charmed circle of ruffling and capering rivals without taking any apparent notice of the cavaliers wooing them and challenging one another in Pistolian bravado.

The capercaillies fan their tails, tense their throat-feathers and dart out their necks on the Scottish pine-branches; ruffs meet in tournament for the ruffless reeves on the tilting ground; great bustards turn up their whiskers, inflate their pouches, stiffen and vibrate their flecked plumage, leap like marionettes and paw the ground. Other species like them, pea-fowl for instance, and particularly game-birds, do seem to follow out the rule of the spinsterish quiescent female and the blindly promiscuous and mechanically desirous male. But there are many exceptions to it even in this class of bird, and Darwin himself has described how the pea-hen sometimes courts the cock and how a homespun mallard-duck wooed, won and successfully mated with a male pintail. If, again, the female is endowed with the privilege of choice and uses it, how can she be described as phlegmatic? No cock-bird on this earth can mate with a hen unless Miss Barkis is willin', so that direct force and all the more subtle expedients of pressure so evilly prominent in human life are utterly unknown in bird life. How, once more, do the theorists of the correct rôles assumed by male and female in the avian Courts of Love account for the courtship habits of certain species where the female is as passionate and determined a wooer as Anne in The Devil's Disciple? She is the literal ruler of the roost. Among the ostriches, rheas, tinamous, phalaropes and hemipodes (bustard-quails), incubation and the education of the young is the charge of the male; among the painted snipe it is the female who is the most resplendent in plumage, while with the phalaropes—Nature's darlings, since she adorns them so comely-wise and hides them away in her wildest retreats—it is the female who is the charmer. He flies and she pursues; she gently and sometimes brusquely presses her suit, passing and re-passing before her reluctant love with arching neck, curvetting above him on ceremoniously waved wing and appealingly bowing before a fellow too bashful to be won without all the evasions, subterfuges and make-believe frigidities deemed to be the perquisites of the other sex.

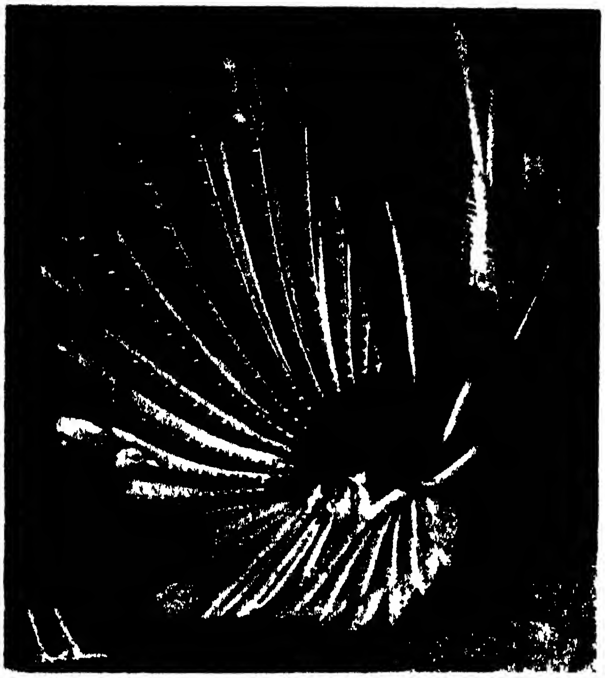
ANOTHER supremely important series of love-making truths, very damaging to this cut-and-dried theory, concern the intricacies of mutual courtship and have been brought to light by those great pioneers of discovery in our age—Edmund Selous and Julian Huxley. Birds are undoubtedly more emotional, more temperamental, but less ready to profit by experience, than the higher mammals. To mammals the fairy godmother bequeathed the gift of plastic intelligence, to birds that of feeling and from it to create that radiance of dress, beauty of form, and grace of flight of which the art of loving has been the parent. For into the mating ardour, birds male *and* female, have packed most of the utilitarian functions of daily life. Huxley has described the honeymoon of the Louisiana egret. The hen will sit on a branch resting

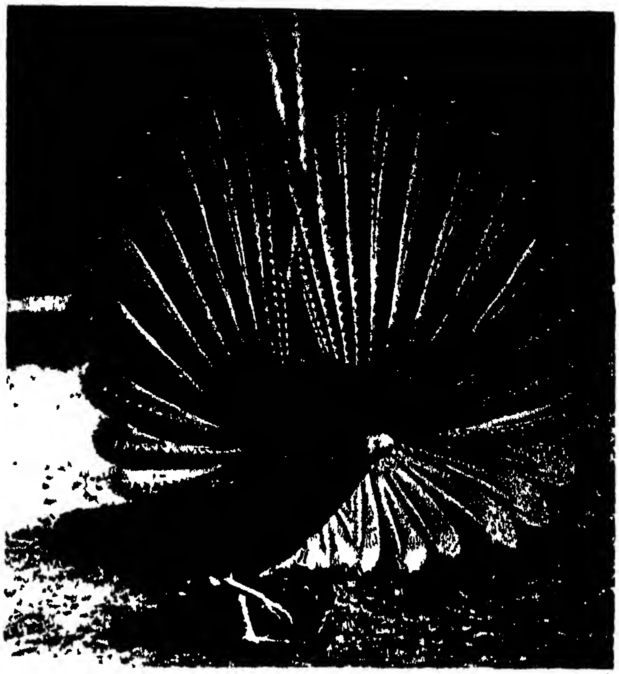


Neville Kingston

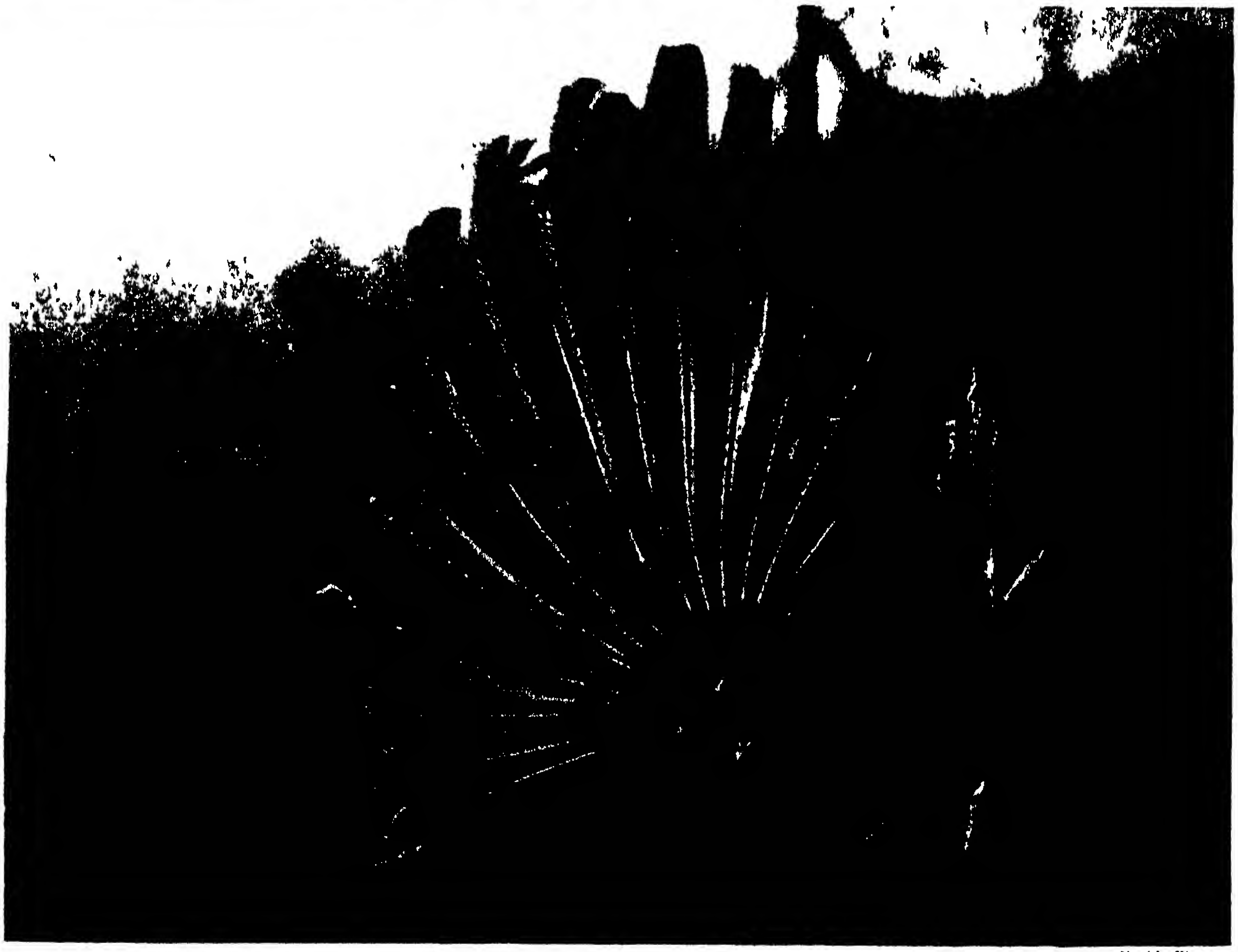
GOLDEN AND PEACOCK PHEASANTS IN THE POSTURES OF COURTSHIP

Perhaps the most beautiful of all its kind is the golden pheasant (bottom), from the wilds of Tibet and China. The gold and crimson of the plumage provide the male bird with a most resplendent livery in which to do his courting. The peacock pheasant (top) takes full advantage of the green and purple "eyes" on his tail feathers, and bows low before his apparently unconcerned mate. Such indifference must be most disheartening even to such a persistent wooing as the peacock pheasant's.





D. Seth Smith



Neville Kingston

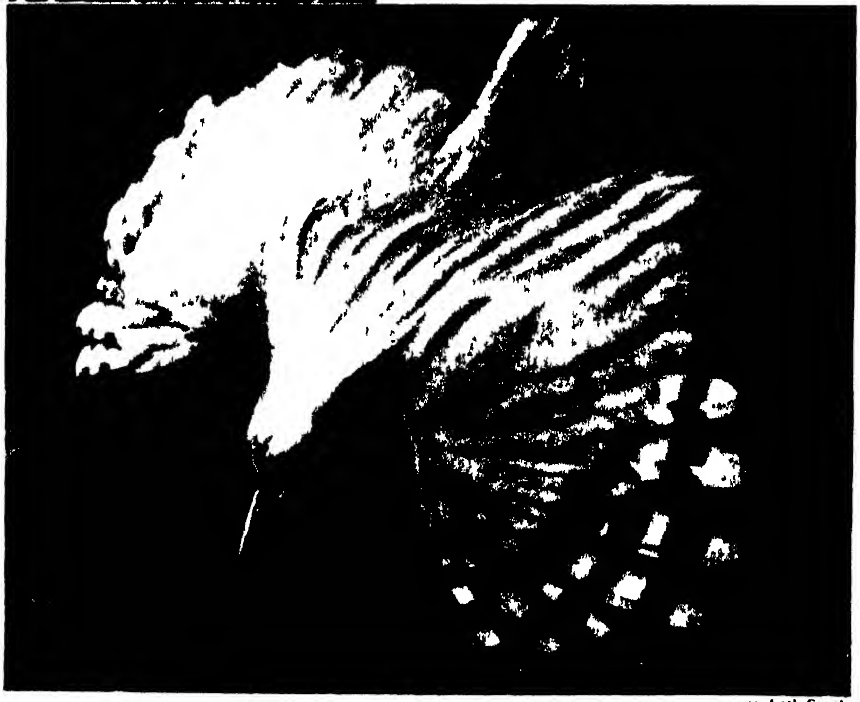
WHEN THE ARGUS PHEASANT'S FANCY TURNS TO THOUGHTS OF LOVE

An extraordinary manoeuvre has been devised by the argus pheasant for his mating season. He throws up his wings in front of his head so that his face is quite hidden, at the same time squinting archly through a chink in the feathers as though to observe the effect of all this impressiveness upon the hen bird. She, however, is so uncomplimentary and so little appreciative as to go calmly on in her search for something to eat. In the lower photograph we can see the eye of the cock bird peering anxiously through.

were wasting their time! Hours of every day unprofitably thrown away in languishment, bushels of nervous energy dissipated in endearments! How uneconomic is the art of love!

Huxley has noted how the red-throated divers have elevated and converted their useful powers of diving and swimming under water into "ceremonials of passion." The kestrel and peregrine falcon, in their wooing flights, employ their powers of swooping down on their prey for exhibition before their mates, and the Adélie penguins offer the stones they use in nest building to their lady-wives with a stately bow, spreading their flippers sideways the while, then raising their heads as though in stilted worship, and humming. The warblers display with twigs or leaves in their beaks, just as keepsakes and valentines are sacred to human lovers. Great crested grebes will spend hours of the day in bouts of shaking pond-weed before each other, their breasts almost touching and reared up to show the flashing under-surface Then the weed is nibbled or exchanged and serves as a love-symbol every bit as important and binding to them as a necklace or

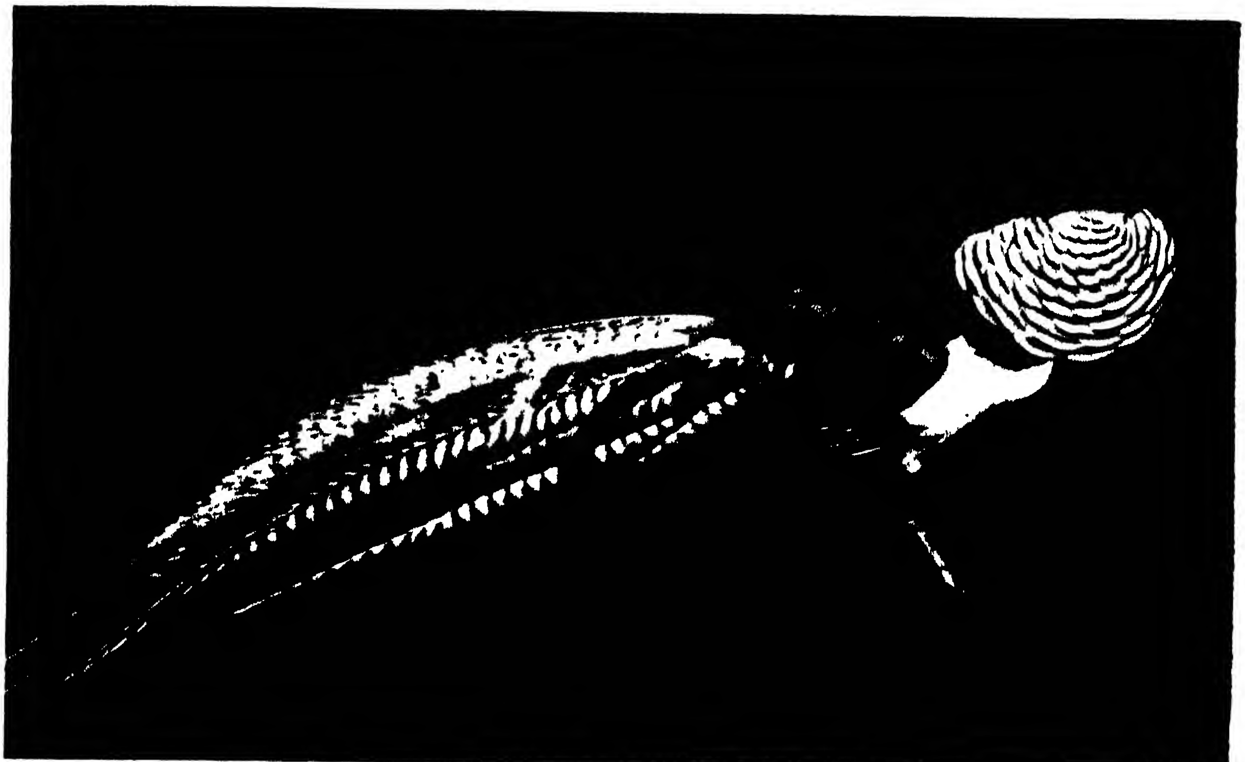
ıer head for hours on end ıgainst the cock's flanks, still, ıs old Chaucer said, "as any ;tone." Suddenly the pair raise heir wings and with solemn oud cries intertwine their ıecks in a true-lover's knot. Then each bird amorously runs the beak through the raised aigrettes of the other, "nibbling and chaffering them from base to tip." Back they sink to their former motionless trance of proximity When one of them goes food-gathering, the other greets his or her return by crying aloud, rising to full length on the branch, arching and spreading the wings, fanning out the aigrettes and head plumes and bristling the neck feathers. And this mutual love-making continues for month after month, long after the young are hatched and flown. Consider how, according to the law of biological utility (invented by man), those birds



D. Seth-Smith

HOW THE KAGU PAYS HIS ADDRESSES

With the kagus the love-making is mutual and not confined to the male, as with the pheasants. The birds lay beak to beak, holding high the plumes of their crests. The male also performs a strange kind of dance with much solemnity, and (bottom photo) bows himself with wings outspread. The kagu is a native of New Caledonia, a French colony in the South Seas.

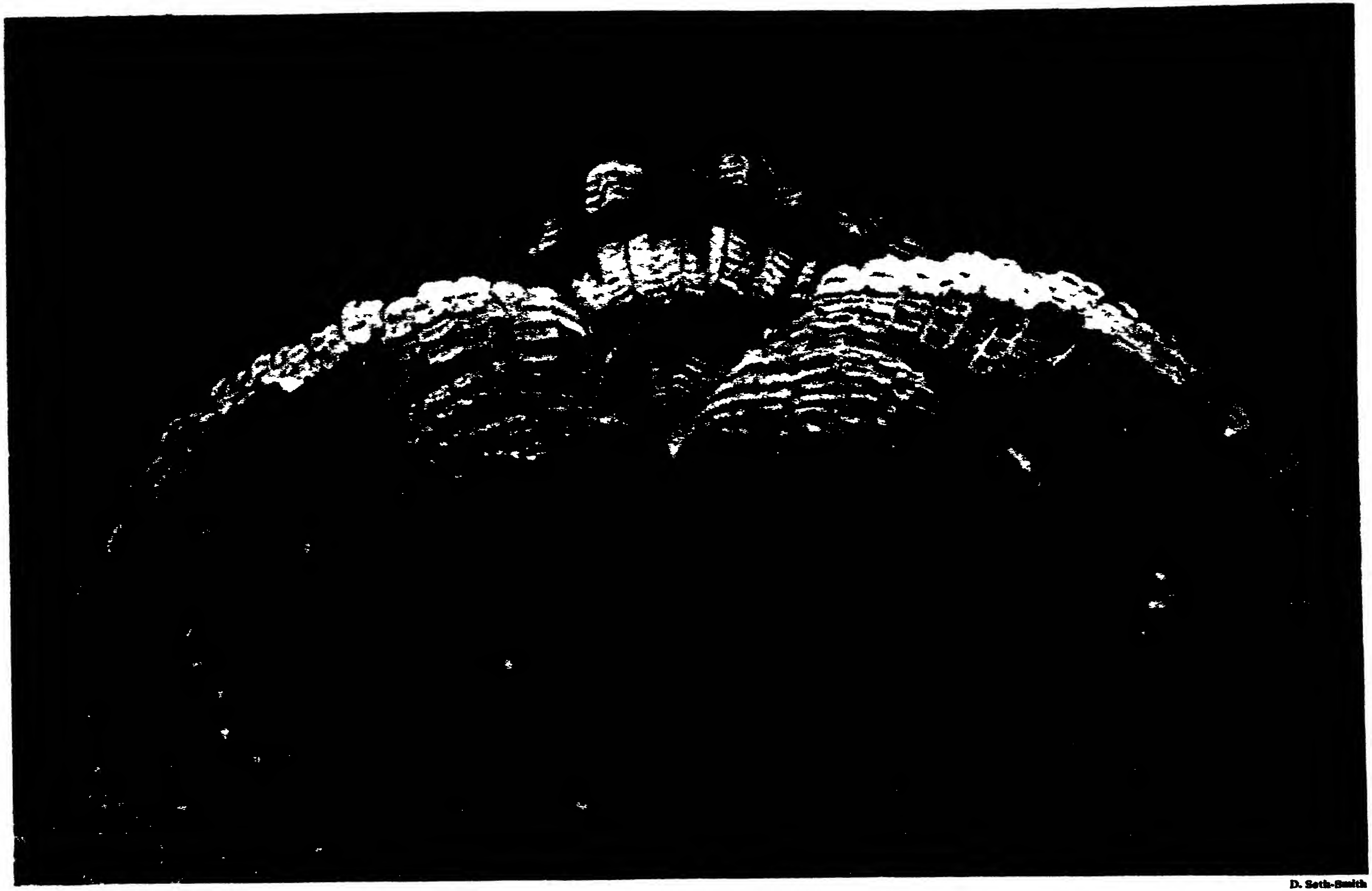


Neville Kingston

D. Seth-Smith

LIGHTNING DISPLAY OF ITS EXPANDING COLLAR BY AMHERST'S PHEASANT

China is the home of Amherst's Pheasant, and this bird has a unique way of expressing his feelings in the mating season. The "collar" which adorns his neck is in a moment shot forward with a flick and then shot back again. Both photographs were taken just at the instant when the collar was at full stretch. The bird looks through the frill at the female to mark the effect on her of this very abrupt and startling display. The whole movement is carried out almost as quickly as the movement of a camera shutter.



D. Seth-Smith

SUN BITTERN PARADES THE SECRET BEAUTIES OF HIS FEATHERS FOR HIS MATE'S DELIGHT

In the ordinary way the sun bittern of Central and South America is not in any way striking for the tints of its plumage. But when the bird meets its mate there is a sudden change which is a revelation. The wings are spread wide and turned up and a wonderful colour scheme of grey, white and red appears. One is reminded of the markings of some beautiful butterfly when looking at these lovely feathers Between the wings the bright plumage of the tail appears, and it seems as though the bird had presented to our view three fans overlapping as in a pattern. It is rather striking that the sun bittern should keep his beauty so secret and that it is only his chosen mate who should know it

D. Seth-Smith

RUFF RESPLENDENT IN HIS WEDDING GARMENT

In the mating season, from the end of May till the last days of June, the male ruff, which has at other times the same plumage as the female, undergoes a remarkable change. A frill, like the ruff of the Elizabethan days, appears round the neck, and above this two large tufts of feathers are formed. In this guise the ruff encounters his rivals in not very serious combat in the presence of the female, though the sham fight may sometimes exceed the limits of chivalrous behaviour. So soon as the breeding month is over these gay garments disappear.

broken sixpence is to us. The sexual life of birds has in fact reached the degree of epigamic development when an extraneous object is invested with emotional associations and so given a kind of life independent of its own value.

If the normal activities of bird life are thus pressed into the service of making love, not for a day and a night but for months at a time, it is obvious that courtship and mating cannot be the perfunctory affair of male epilepsy and female acquiescence the Victorian dislike of our kinship with the animal kingdom (combined with their ideas of feminine sexual repression) assumed it to be. From this point of view, the courtship of the great crested grebe is wonderfully instructive. In the first place, the female is, if anything, often more "forward" in wooing than the male, while the rôles of typically masculine and typically feminine are constantly interchanged, just as the most perfect manifestations of human love flower when a man has a feminine tincture in his make-up and a woman something of the masculine salt. Thus, each sex is in a sense the creation and creator of the other, for each in turn enacts the other's part, the female bold and dashing as the male, the male as softly blandishing as the female.

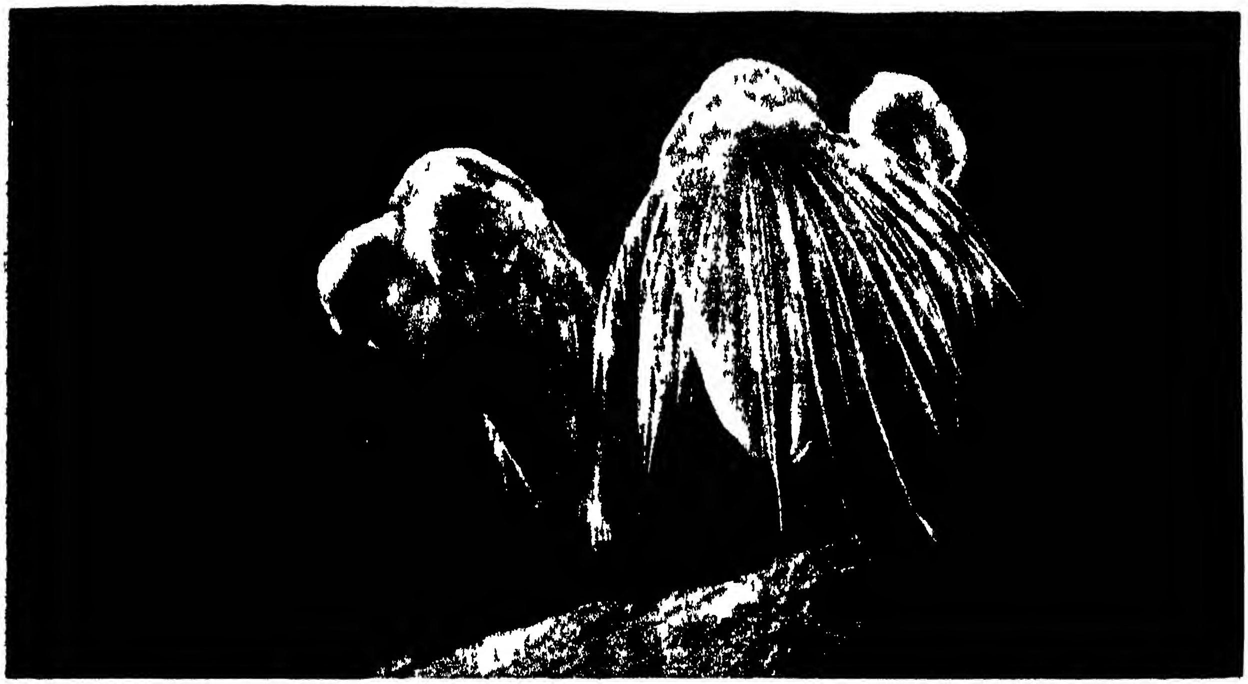
It is plain, too, that the rhythms of endearment, tenderness and almost ritualist caressing by which the complex hymen of these birds is conducted and prolonged carries us far beyond the exclusively physical greeds and surrenders of the Victorian theory. The physical element is part and parcel of the biological. Nobody can watch grebe courtship without being struck by its harmonies, as though each bird were acting in a pre-ordained drama, and I defy any unprejudiced observer not to exclaim, "Why, these birds are in love with each other." They approach each other with the necks lying along the water and when breast to breast leap upright and seem to stamp the surface of the water with their shields gleaming an iridescent white in heraldic opposition.

The hen-bird catches the dangling weed in her mate's beak and each bird sways from side to side to, as it seems, an unheard melody, or treading water a few steps forward and then back. Or they will throw up their heads, opening and closing their beaks with formal grace, the Elizabethan ruffs outfanned below them. I have seen ravens performing similar motions and then, joining their beaks, swing to and fro, with depressed wings in a kind of blissful enchantment as

Neville Kir

EGRET WHOSE WONDERFUL WEDDING GARMENT NEARLY LED TO ITS EXTINCTION

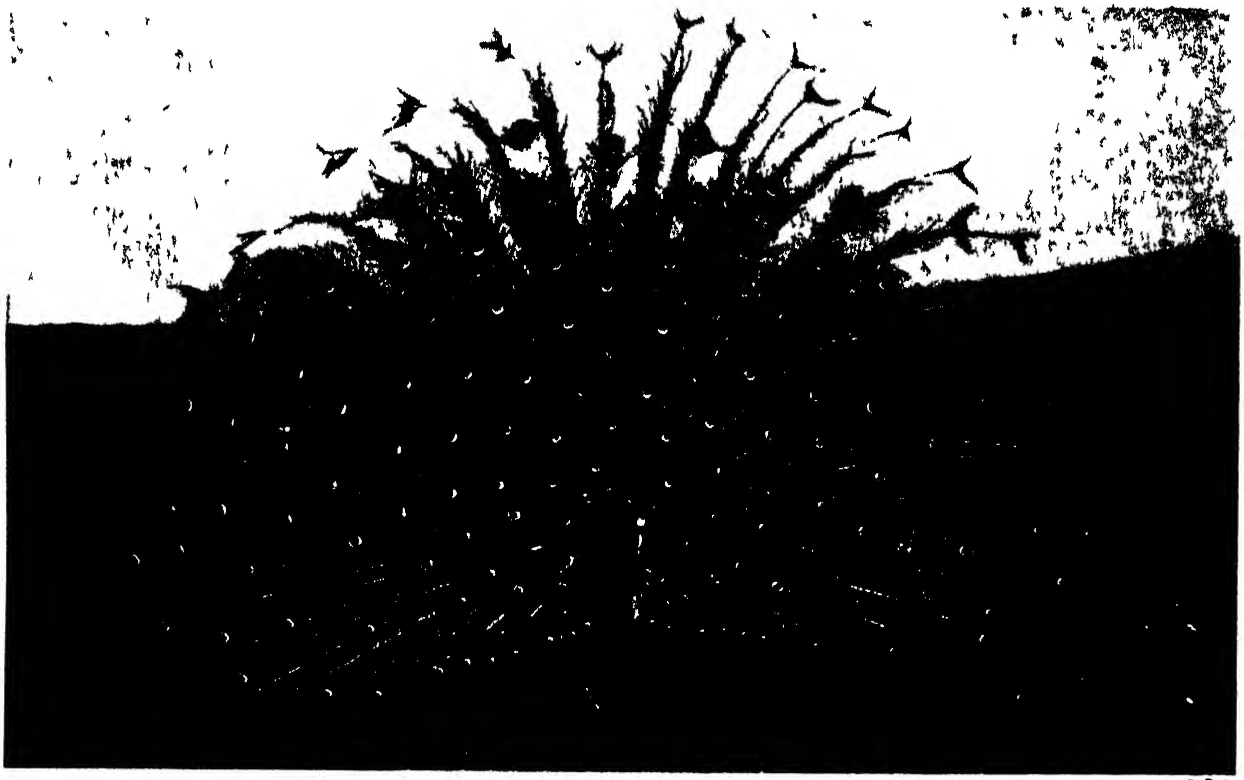
All over the world the egret which is a white species of the heron family, was slain in thousands during the mating season for the sake of the feathers called aigrettes or ospreys which were highly valued for feminine adornment The feathers in question consisted of beautiful silky filaments hanging down the back in the case of the Great American Egret seen here. These lovely plumes are only worn —both sexes have them—in the mating season The civilized nations have now banded together to discourage the ugly trade in ospreys



Neville Kingston

SNOWY AND GREAT AMERICAN EGRETS IN BRIDAL PLUMAGE

As a penalty for being beautifully robed in snow-white feathers during the season of mating, the egrets were nearly exterminated. But, just as wild flowers are the more delightful when growing in their natural place, so we can see from these photographs of the egret that its feathers are only seen at their best on the bird as it lives. Stuck in a hat or a fan they lose the marvel of the purpose for which they were made. Below is one of the snowy egrets found in Florida, and above a couple of Great American egrets keeping their wedding finery in order



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Neville Kingston

PEACOCKS DISPLAYING THE WONDER OF THEIR TRAINS TO INDIFFERENT MATES

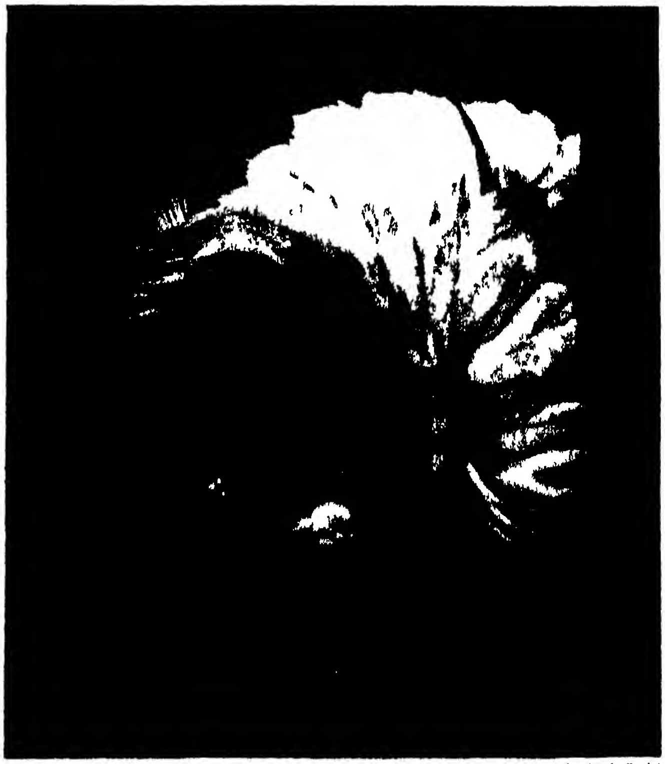
Tail coverts are prolonged in all the peacocks far beyond the length of the tail feathers themselves, and it is this covering which, when expanded, makes the glittering splendour which is usually referred to as the peacock's "tail." India, Ceylon and Assam are the native homes of the peacock, where it is found in the jungles near water and usually near cultivated land. Since, in India, the birds have been regarded as more or less sacrosanct they have bred with little molestation. No bird has such an imposing gesture to make before his mate

though their bodies rolled to the monotonous plaint of an Hawaiian folk-tune. Sung under a South Seas moon to the passionate throbbing of ukuleles and steel-stringed guitars

Selous has maintained that the courtship of birds absorbs their functional behaviour to such an extent that it is responsible for nest-building Thus the nest of the great crested grebe is a bower, a love-couch, what the ancients called a " thalamum " The grebes make a love-play out of the materials of the nest, and this is likewise true of lapwings (whose hardly credible powers of madcap wing display are the product of nuptial exaltations), of thrushes, blackbirds, rooks, swans, divers and pre-eminently of the bower-birds, whose ornamental nests are primarily a love-offering

THE lapwing advances towards his or her mate in a set, mesmeric attitude, halts, raises the tail and falls into a peculiar rolling motion which scoops out the nesting hollow Both sexes fall into the same curious hypnosis So the wheatear spins round like a slow-motion top, crouching in a hollow and plucking and dropping wisps of grass Nest-building and elaborate and truly aesthetic forms of sexual display have thus developed concurrently out of a formless and primal urge. In 173 out of 212 species of British birds, the male aids the female in constructing the nest, and, if mating and nesting are parts of one whole, it is clear that both sexes are equal participants in all the solemn and significant fervours and ceremonies of courtship in this joyous and almost ritual beginning to the renewal of life by virtue of the ardours of parenthood

Of this truth there are so many examples that it is possible to formulate a general law which radically differs from the Victorian theory Where the sexes are alike in plumage or one sex is as beautiful as the other active courtship is mutual The fact that it is the cock-bird who usually sings offers no real difficulty, because, as Selous has pointed out, all nuptial notes are a kind of song and these are uttered equally by both sexes of a vast number of species I may even go further and suggest that those species in which the female or the male is the monopolist in courtship are sidetracked off the trunk lines of evolution These are usually polygamous In the interchanges of love-making, frequently prolonged long after the young are hatched and certainly

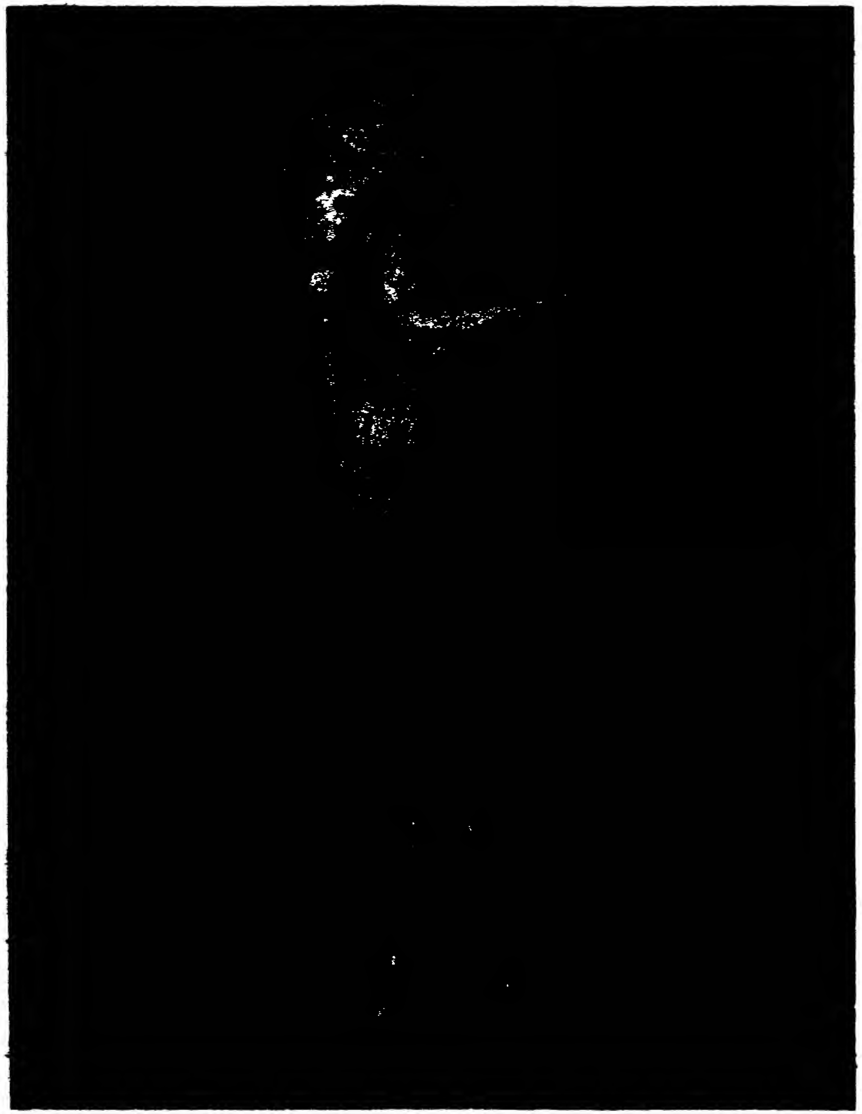


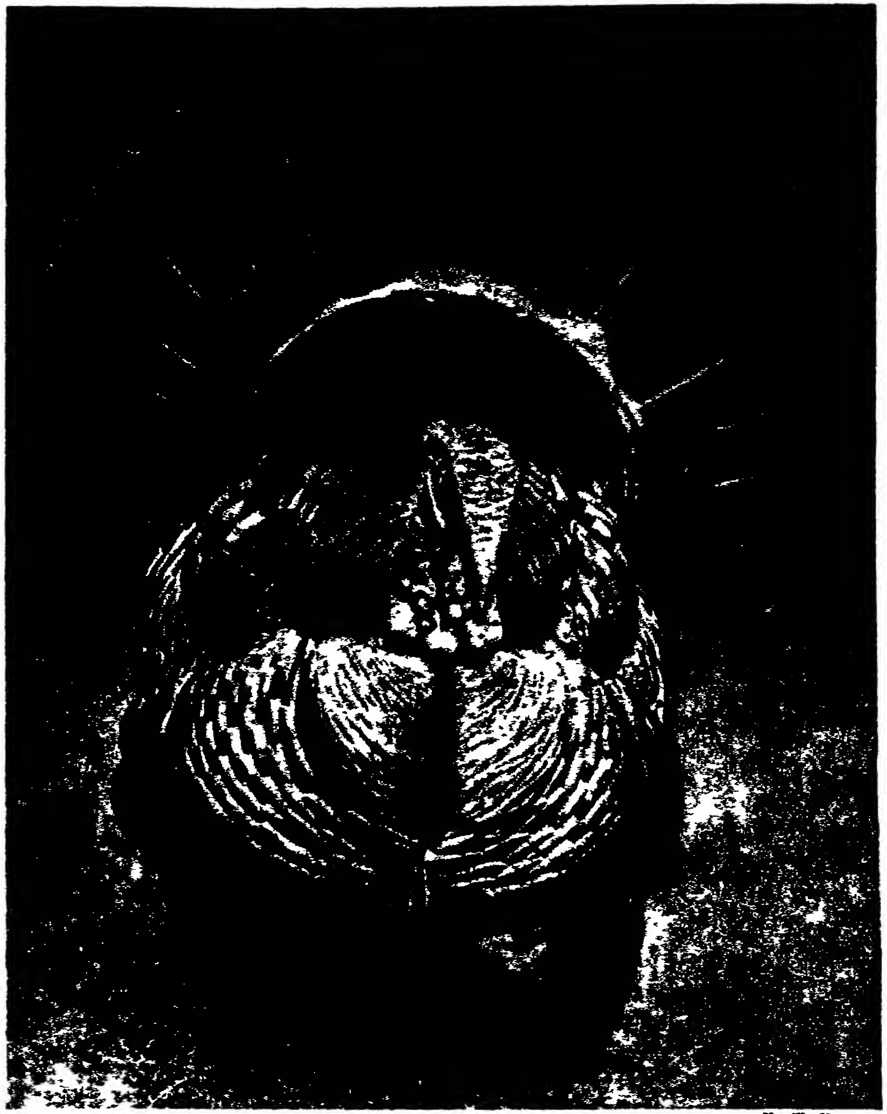
D. Seth-Smith

GREAT BUSTARD AND A TURKEY "DISPLAYING"

When displaying for the benefit of the female the bustard (bottom) inflates an air pouch in its throat and extends its quill feathers, thus appearing to increase in bulk. The turkey (top) makes the most of its markings and its wattles, as we see here

resumed in the following season, the male exercises as much choice as the female and the female as much initiative as the male. Thus the process of sexual selection is a double one and each sex has " acquired





Neville Kingston

AN AMOROUS TURKEY AND THE EXTRAORDINARY EFFECTS OF COURTSHIP EMOTION ON THE MAQUARI STORK

Despite its name the turkey (right) which we see making a great fuss in the hopes of impressing some hen-bird—turkeys are polygamous—has nothing to do with the land of Turkey. It is a native of North and Central America, and was unknown in the Old World before the end of the fifteenth century, when the explorers of new-found America brought back some specimens. Turkeys were probably introduced into England by ships trading with Turkey, which had called at Spain on the homeward voyage and picked up the birds as a novelty. This, or some similar course accounts for their name. The Maquari stork (left) from South America goes through the most amazing contortions, bearing its beak right back and making its throat feathers stand up like a sugar loaf.

D. Seth-Smith

SIMPLE BUT PROUD DISPLAY OF GIANT WINGS BY THE CONDOR

Largest of the birds of prey, the condor lives among the vast peaks of the Andes and belongs to the vulture family. But it feeds on living things such as lambs and kids as well as on carrion. Its great wings may measure as much as eight feet from wing-tip to wing tip, and in the breeding season, the male spreads these pinions, the symbol of his great power, before his mate. Condors nest on the rock ledges among the mountains, but in the ordinary way go to roost by companies in the trees. The condor is not found outside South America.

such beauty as it possesses in accordance with the taste and choice of the opposite one." The theory that the male is wound up to a kind of indiscriminate and mechanical fury, while the female is the apathetic recipient of his attentions, fails to explain why the sexes remain constant, as they surely are more likely to do when they mate by what has been called an "elective affinity" formed out of mutual ardour and founded upon mutual preference.

LET me give a few more examples of mutuality in the lyrics of sound, gesture and colour each sex contributes for the delight of the other. Darwin, with his usual fair-mindedness, has described how the hen capercailzies flit round the males as they parade, and this instance is the more remarkable in that the species is polygamous, and the hens are drabs whose responses are held to be inactive. When the South American jacanas, a species allied to our water-rails, display, male and female vary a rapid fluttering with a slow butterfly-like heave of the wings. The dingy-hued hen-blackbird expresses her appreciation of her mate's prancings and posturings by a beatific drooping of the wings. A pair of red-throated divers will both utter a wild epithalamic cry with the neck held arched and rigid and then with heads and necks lying flat along the water and bodies almost submerged, they will advance very joyfully to meet each other in a series of little plungings.

The manikins have a wooing song and dance in which the cock and hen keep hopping up and down alternately, singing tolédo, tolédo ("to" at the crouch, "lé" at the spring and "do" when they alight). Albatrosses will waddle round each other for a quarter of an hour at a stretch, though walking is very arduous for them. Then they will interlace their necks and rub them against each other's downy feathers. The bills are tucked into the wing and then tossed in air with a mixed groan and scream. Like so many long-billed birds, they snap their beaks and join them, blowing out their breasts the while. Mated cranes pursue their amorous exchanges by hopping and skipping about each other, by little pirouettes and more stately minuets. Fulmars indulge in mutual languishing motions, while the males and females of the shag tribe display the brilliant gamboge of the mouth for each other's delectation. Why, asks the clear-minded Selous pertinently, should the habit have survived if his revelation of his treasure had not been for her and her similar response for him?

Many instances, again, have been collected of jealousy operating so forcibly among the hens of oyster-catchers, Kentish plovers, redshanks and other species that they will drive an intrusive male right out of the lists of love. This very definite contradiction of passivity or indifference in the female has even been observed among the dowds of

polygamous species like blackcock, ruffs and reeves, peafowl and others. It certainly gives birth to a suspicion as to whether the females of any species are ever such lack-lustre, passionless creatures as imperfect observation has described them. There may be other reasons for this seeming lack of interest in the male's desperate devices, and if that is the case, one wonders whether the so-called polygamous species are not rather promiscuous than Oriental in their nuptial customs. And it is unquestionably true that it is the females rather than the males of some species where love is shared and active in both sexes who open the ceremonies by making emotional advances to their partners.

The whole problem is one of unique interest because in love between the sexes mankind is nearer to the birds than to the mammals. It is only among birds and men that courtship reaches an emotional and psychical complexity lacking to mammals and the more lowly organized members of the animal kingdom. When we study the mating habits of birds whose courtship is mutual and who pair for life, one is forced to the conclusion that men and women only differ from males and females of the wild birds (domesticated animals are nearly always degenerate) in three respects. Mankind has been released from the biological tyranny of the mating season in the first place. Secondly men and women bring, or rather are capable of bringing, a higher mental evolution and a more subtle play of emotion to their love making than is possible to birds. And, thirdly our natural feelings have been modified, sometimes out of all recognition and not infrequently to the heavy detriment of human values, by our social institutions. But these are differences not of kind but of degree

The Victorians made their great mistake when they attempted to separate the loves of men and birds as different in kind. As Selous has written with such passionate irony:

> There must be no preferences, no love-matches here (namely, in the kingdom of birds). All must be in obedience to a blind sexual instinct, something very animal, about which we, of course, know nothing Unlike ourselves, the female brute must be ready to mate with any male brute chance may throw in her way, and, if it throw several, she must be absolutely impartial between them, there being neither looks, soul, nor money for her to found a choice on Therefore she will go to the strongest and know no better, for love she knows not, nor can parental authority and filial obedience combine here to give the preference to riches or title, coupled with age or disease.

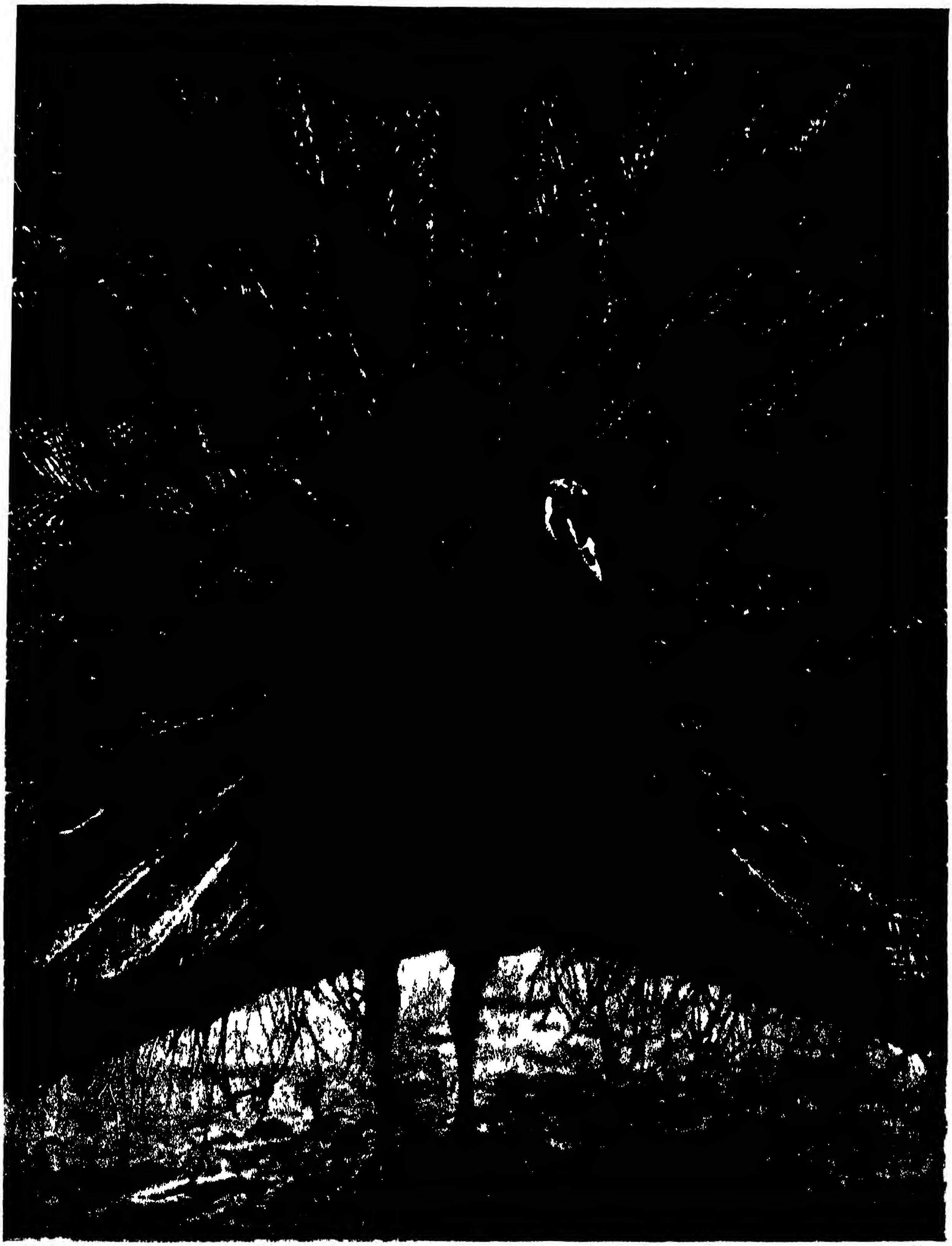
When the Victorians elaborated the theory of the sexually excited cock-bird (as though he were a kind of rotary machine stimulated by a biological accelerator) and the passive hen-bird (as though she were a kind of inanimate lightning-conductor), were they more influenced by the society of the time than they would have cared to admit? Is the "coyness" of women an institutional rather than a natural endowment, and is the axiom that man is the wooer and woman the wooed a passing phase of social convention? At any rate, a study of the mating habits of birds lends no support to it, for what we call "equality of the sexes" is the predominant law in that kingdom, and it is highly probable that the permanence of union which is so striking a character among so many species is the consequence of that equality, which takes the form not of competition between the sexes in the feministic fashion, but of mutual cooperation and an equal ardour in the joys of matehood. When our grandmothers submitted to the cruel laws of Victorian marriage, either they were acting a part in obedience to male domination and the repressive standards of conduct then prevailing or the "marriage of convenience" left them permanently unlit. Such passivity was at that time deemed a virtue.

The courtship of birds shows us a better way. The biological urge of the sexual instinct has undergone such a development that the brilliant colours; the exquisite graces of flight and movement in the air, where migration or food-catching is not the motive; melody; ornamental structural characters; prolonged rites of courtship and mating; equal ardours, affections and constancy, have all been built up from this primary force. When we on our plane ally the instinct with which we are born to the spiritual on the one hand and the natural on the other, the experience of great men and of great lovers has often proved that there is no real disharmony between them. Let us praise the birds who have shown us on their plane what possibilities in the co-operation of heaven and earth are open to us on ours.

Neville Kingston

BRILLIANT TRAGOPAN OR HORNED PHEASANT

Among the bamboo woods of China and India lives the tragopan or horned pheasant which is celebrated for its remarkable brilliance and beauty of plumage. In the mating time the male birds perform the most elaborate displays, giving the full effect of their intricate markings and resplendent colourings as all the pheasants do.



GLORY OF GLINTING PLUMES AS THE PEACOCK SPREADS ITS TRAIN

[illegible] the wonder of the spectacle of the peacock's train [illegible] the riches of an emperor to dazzle the eyes [illegible] the wonder [illegible] Amid the exquisite [illegible] work of the plumage appear [illegible] many watching eyes which gleam now green now blue. This is due to the formation of the [illegible] The train is an extension of the tail [illegible]

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Chapter XIX

The Attitude of the Animal to Man

By Dr. R. C. Macfie

It requires two to make a quarrel or a pact, and the attitude of animals to man depends largely on the attitude of man to animals.

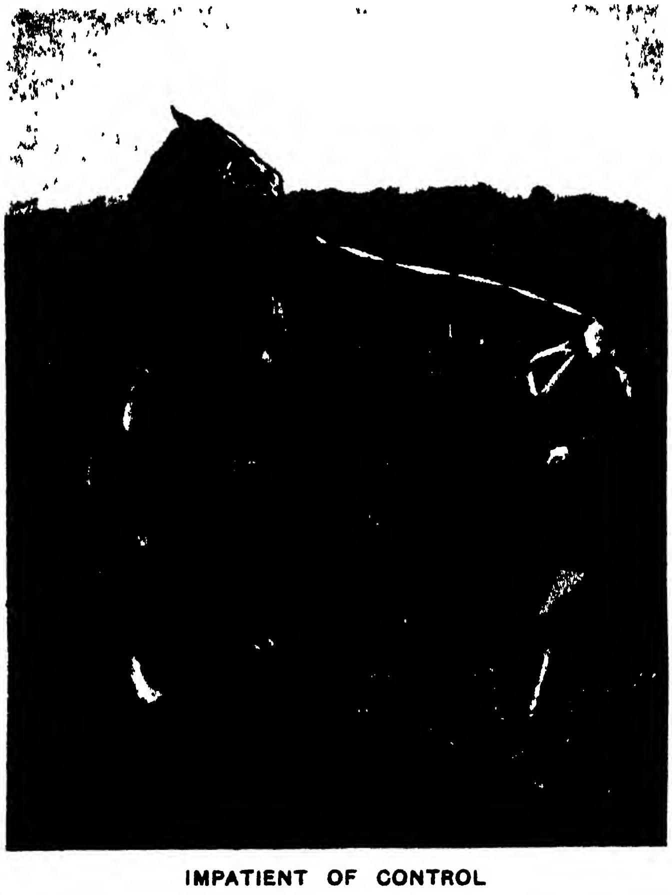
Man himself is merely an animal; through animals he evolved, and in bone, nerve, and muscle he carries indelible record of his animal ancestry. From the worm he got his red blood, from the tunicate his backbone, from the fish his camera eye, from the triton his five fingers, from the duck-billed platypus and the ant-eater his mammary glands; from the kangaroo his nipples; from the hedgehog and anaptomorphis his placenta and his neo-pallium. Yet ever since he swung himself down from the trees and became *homo erectus*, he has been at war with most of his animal kindred He began his human career, not as shepherd nor as farmer, but as hunter. As cave-man, he fought the sabre-toothed tiger, the woolly bear, the mammoth, and the hyena; and fishes, birds, and beasts were regarded almost exclusively from a gastronomic standpoint.

That was natural enough. A man sharing a jungle with beasts of prey has to choose between being feeder or fodder. A man who has no milch cows and no cornfields, must kill to get meat for his larder and must not be too particular what he eats—mammoth perhaps for breakfast, an undercut of tiger for luncheon, and loin of bear for supper. Man was a hunter and the animals were his food.

But in time he learned more wisdom: he discovered that co operation was some times more profitable than competition, that tamed animals had their uses, that a living dog was worth more than a dead lion—that it was more convenient to keep meat alive in a paddock than dead in a larder. He found he could dominate an animal more effectively by taming it than by maiming it, by harnessing it than by trapping it, by milking it than by hamstringing it, and his whole attitude towards the animal world and towards life underwent a change. Civilization, indeed, may be said to have begun with the taming of wild grass and of wild animals; and the domestication of the wild ox or aurochs may be said to have been the foundation of the home. On a horse civilized man rode to war; with a sheep's wool he covered his nakedness, in a cow's udder he stored his daily food.

Some of the first treaties with animals required courage and enterprise: it required the courage of a lion-tamer to bit, bridle and saddle a wild stallion, and the enterprise of a Lindbergh to milk a wild mare; for in those days of struggle to survive there must have been incorrigible distrust between man and other animals.

Strangely enough, the very first addition to man's household as a boarder was one of the ravenous wolf tribe—a boarder now known as the dog. It is difficult to believe that primitive man ever tamed or tried to tame a wolf, for wolves are extremely intractable and treacherous animals. It is more likely that the primitive dog adopted into the human household was a hybrid, which had lost in the crossing most of its wolfish vices, and much of wolfish appearance. To-day there are several genera of the family-Canidae, to which wolves belong—wolves, jackals, dingoes, foxes, and so on—and a cross of some of them or of genera now extinct may have produced a tameable animal.

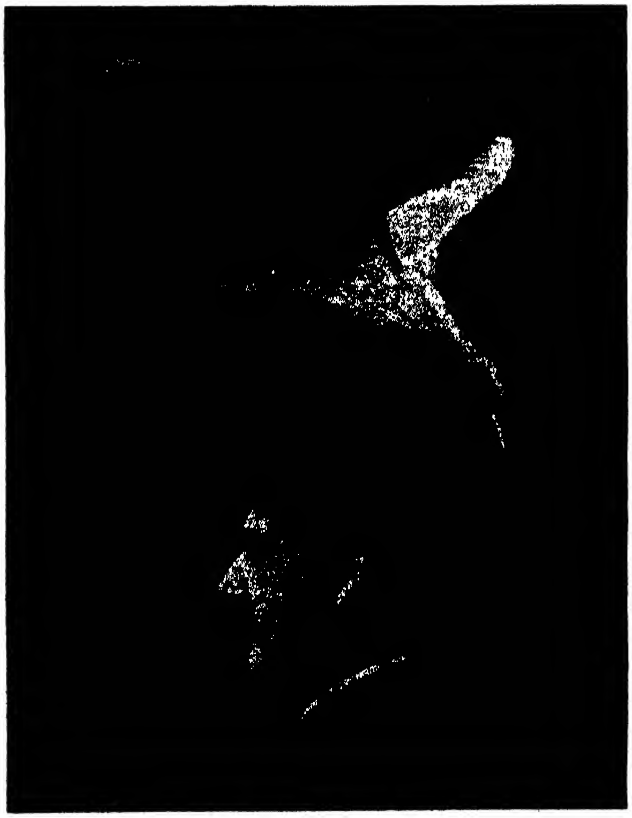


IMPATIENT OF CONTROL

Generations of service on behalf of man have not tamed the natural longing for freedom and impatience of restraint in the horse. Here is a fine stallion on a stud farm in Sussex, wildly pawing the air at the end of his long rein although he sees his master every day.

A dog's likes and dislikes are mainly of olfactory origin, and it is quite possible that 'freaks' born with an innate liking of the human odour went up to man with a wagging tail. Or it

J.G. Wells



BIRD AND BEAST GAIN CONFIDENCE UNDER THE RIGHT TREATMENT

A spider monkey at the London Zoological Gardens found a friend he could trust in a schoolgirl (bottom left) who spent much of her holiday time there. Less intelligent creatures than monkeys get to know their friends. One of the sea-gulls which frequent the Serpentine in Hyde Park (bottom right) perches on the hat of a man who regularly feeds it. A trumpeter bird, naturally very shy, does the same for its keeper (top left) and the squirrels of Regent's Park are notoriously tame when they can scent food to their liking (top right).

HORSE AND RIDER—COMPANIONS AND FRIENDS

Arduous service is the lot of horse and man in the Canadian Mounted Police—formerly known as the Royal North-West Mounted Police—and it is hardly to be wondered at that the rider gets fond of the animal on which the successful performance of duty and even life itself must often depend. This is a sharp contrast in the horse's attitude shown with the photograph in page 183 and a reminder that to win the confidence of even the domestic animals needs competence care and experience.

may be that the first domestic dogs were adopted as puppies, and were tamed by a domestic environment. There seems to be an instinctive desire in most men and children to make pets of young animals, and petting can modify an animal's innate character. In Australia there is to-day a wild dog-like animal, the dingo, which hunts and destroys sheep, and yet if it be domesticated as a puppy it can be trained as a sheep-dog.

However the association between man and dog came about, it is certainly an association of great antiquity and of great mutual value. Man has no alliance equally intimate with any other animal outside his own family, and the friendship of the dog for man is quite unique in its loyalty and many-sidedness. All breeds of dogs—and there are now about two hundred—instinctively trust mankind, and even dogs naturally fierce, are gentle with children, and obedient to their masters. There is indeed a reciprocal affection between dog and master, and a dog will defend its master and its master's property even to the death, and, if it lose its master, will sometimes refuse to eat and will die of sorrow and grief. Ulysses' dog Argos died of joy when his master returned, and as we write it is reported in the papers that a boarhound is so inconsolable over the suicide of his master that he will probably have to be destroyed.

MAETERLINCK says that the dog is "our intimate and impassioned slave whom nothing discourages, whom nothing repels, whose ardent trust and love nothing can impair," and in "The Blue Bird" he makes the Dog say, "There is Man, and that's all. We have to obey him and do what he tells us! That is the one and only fact! I recognise no one but him! Hurrah for Man! Man for ever! In life and death all for Man. Man is God." In every case the dog seems to accept man as leader of the pack, as comrade and as playmate, and in most cases seems able to differentiate between master, friend, stranger and enemy.

So faithful is the dog that in medieval monuments the dog is placed at the feet of women to symbolise

affection and fidelity, and many of the Crusaders are represented with their feet on a dog to show that they followed the standard of the Lord as faithfully as a dog follows its master.

DURING bygone centuries man has been selecting the most intelligent and affectionate dogs, and so canine intelligence and affection have probably increased; but dogs have also been bred for other purposes and to this purposive breeding we owe the remarkable breeds of dogs that tend sheep instead of worrying them, the Eskimo sled dogs, that drag the sleds wearylessly across the ice the setters and the pointers, equipped with "all-testing, all inquisitive nose."

In some cases dogs are taught to be docile only to their masters and to attack strangers, and there are, of course, breeds of dogs naturally fierce and treacherous; but dogs as a family regard man as a god to be followed and obeyed. According to Thaler most dogs are exceedingly sensitive to ridicule, and never forgive a man who ridicules them. The bark of domesticated dogs would seem to be a step towards language, for it is not found in savage dogs, and is most particularly and strongly developed, and most flexible of the needs of varying emotional expression, in highly-bred dogs.

The cat was probably domesticated a little later than the dog, and, as in the case of the dog, it is difficult to explain its first domestication, for a wild cat is even more untameable than a wolf. Domestic cats of all kinds have intelligence and grace, but though they may have affectionate manners they seem to lack true affection, and never show implicit faith in any man. Except as "mouser" and as ornament the cat has little social or economic value.

UNUSUAL "ATTITUDES" OF MAN TO ANIMAL

The charms of music have always been held to be a link between man and animal from the time of Orpheus to the Pied Pipe of Hamelin and onwards. A nightingale can be stimulated to sing by a 'cello and some similar sort of attempt is being made by the Zoo keeper and a cockatoo A six-foot diamond python (top) can be affectionate enough to lick its keeper's face.

It sits in "monumental calm"
immobile, imperturbable,
Like one whose vision seeks the Imminent
Behind these symbols and appearances,
The face within this transitory mask

Much more valuable as a domestic animal is the horse. Civilization without horses could not have made much progress, for it was mainly their horse power that enabled the Aryan races to conquer the barbarians, and the Spaniards to conquer Mexico and Peru. Horses had their original home in the steppes of Central Asia, and the first horsemen were Mongols.

Strength, endurance and size made the horse valuable in agriculture and transport; and, though now it is being ousted

WHEN MAN AND BEAST CAN TRUST EACH OTHER

Even in the wilds of Canada the bear is sometimes agreeable to an armistice in the eternal quarrel with man. In this case we have one of the privileged bears which live, for ever protected, in the Kootenay National Park in British Columbia. No one ever harms the animals and consequently some of them have learnt to treat man as a friend

by petrol and steam, the part it has played in the past must never be forgotten. Yet the horse is not a particularly intelligent animal, and, though it has a certain amount of affection for the hand that feeds it, the feeling cannot be compared with the intimate affection of a dog. A horse is little more to man than a machine: its response to whip and rein is mainly reflex and automatic, and man is little more to a horse than whip, rein and nose-bag, and manger. Even the mule has more intelligence than a horse. Still less intelligent—though it, too, has played a part in civilization—is the camel, which clothes, carries and sometimes feeds its masters. It is considered by Thaler to be "the dullest and least improvable of all our servitors." Its attitude towards man seems to be that of a stupid and unwilling yet patient drudge.

Possibly the most intelligent of all living domesticated animals is the elephant. What courageous man or nation first subjugated and harnessed an elephant is not known; but a mighty and fearless man he must have been.

The readiness and rapidity with which an elephant adapts itself to captivity and to association with man is most remarkable. Within a few months it is quite friendly, and in a short time is willing to co-operate in the capture of its kindred. It is easily taught to do certain kinds of mechanical work—even work requiring some skill and some use of the reason—and it is as faithful as a dog in its attachment to man. It quickly distinguishes between individuals, is capable of remembering kindnesses with gratitude and cruelties with hate, and is almost human in its attitude towards man.

Coming to the mammals of the farmyard, we find little to encourage us to believe that they have much, if any, personal feeling towards man.

The subjugation and domestication of aurochs, boar, wild sheep, and wild goat marked a great step in the progress of civilization, rendering possible villages and communal life. Wild bull and boar have been changed into the comparatively dull and sluggish ox and pig, and marvels of breeding have been accomplished so that a milch-cow may give twelve times its own weight of milk in the year; but the tame animals regard man with indifference, neither loving nor fearing him. The shepherd may love the sheep and call each by name; the collie may watch over them with a solicitude almost maternal, but the sheep take little interest in either shepherd or sheep-dog, and even the Irish pig in the Irish shanty has little interest in its human fellow-boarders.

In the barnyard the same attitude of indifference prevails. Cocks, hens, ducks, geese, turkeys, regard their owners merely as purveyors of food, while the ostrich is notorious for its stupidity. This is probably

FOX AND FARMER, LIFE-LONG ENEMIES, ENJOY EACH OTHER'S COMPANY

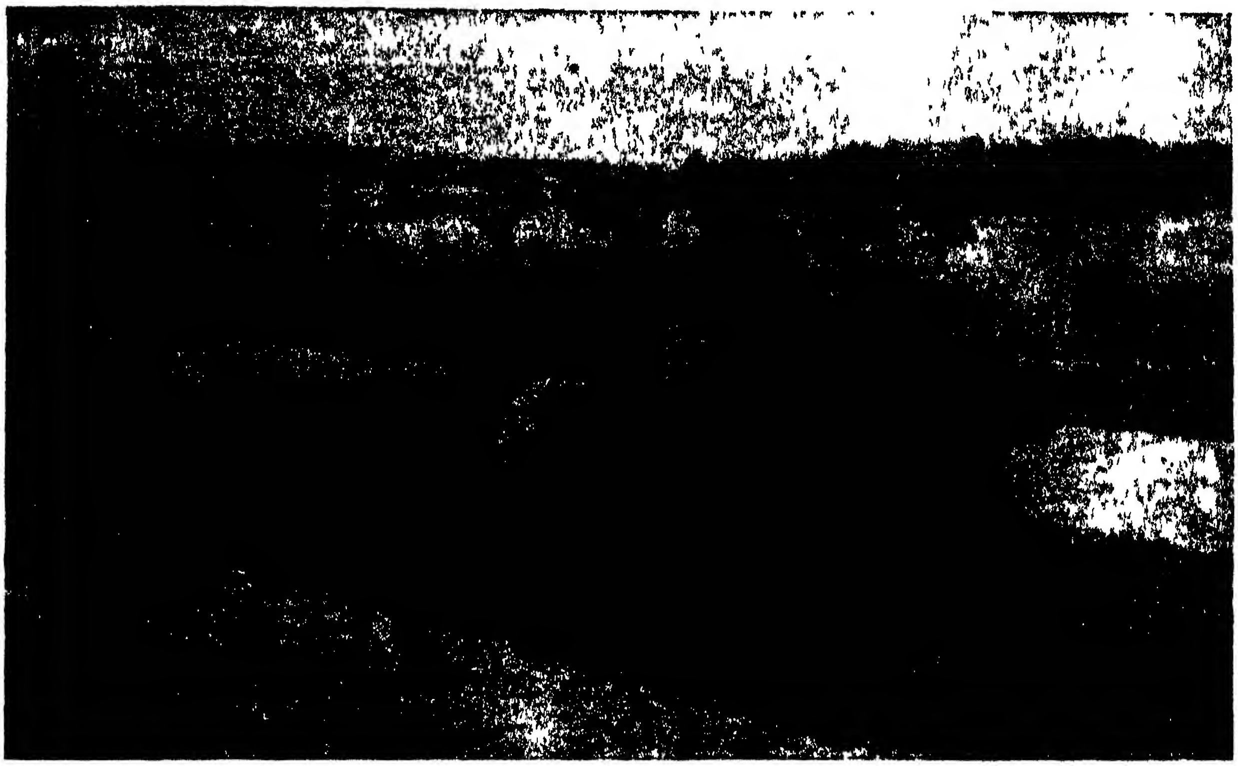
An excuse for fox-hunting is that it keeps in check one of the pests of farming. The cunning of Red Reynard in the raiding of hen-runs is proverbial, and the farmer is the last person liable to keep a fox as a pet. Yet one farmer in Sussex has kept a fox which has become used to following him about just as a dog might do. Even on a fishing expedition the two friends share a boat together, and thoroughly enjoy themselves too as we see. Never was a greater paradox in man's customary relation to the animal.

simply because no particular physiological reaction to man is necessary for their welfare or safety. A wagging tail may have survival value for a dog; it has none for a turkey, which is bred mainly for its pectoral muscles. On the whole, domesticity makes for stupidity leading to the loss even of instinctive wisdom and initiative.

Of domestic birds, the parrot, kept chiefly for amusement, is certainly the most intelligent. Its grip and its powers of articulation and mimicry seem associated with a certain capacity for affection. At least, it seems to recognise individuals and to regard each with varying degrees of friendliness and trust.

To quote Maeterlinck again: "A few creatures fear us, most are unaware of us, and not one loves us. Among the animals we number a few servants who have submitted only through indifference, cowardice or stupidity: the uncertain and craven horse, who responds only to pain, and is attached to nothing; the passive and dejected ass, who stays with us only because he knows not what to do nor where to go; the cow and the ox, happy so long as they are eating, and docile because for centuries they have not had a thought of their own; the affrighted sheep who knows no other master than terror; the hen, who is faithful to the poultry-yard because she finds more maize and wheat there than in the neighbouring forest. I do not speak of the cat, to whom we are nothing more than a too large or uneatable prey. They do not love us, do not know us, scarcely notice us. They are unaware of our life, our death, or departure, or return, our sadness, our joy, our smile. For thousands of years they have been living at our side as foreign to our thoughts, our affections, our habits, as though the least fraternal of the stars had dropped them but yesterday on our globe."

Maeterlinck is perhaps too pessimistic, but nevertheless it is probably true to say that dogs, horses and elephants apart, domestic animals are indifferent to their owners and do not appear, so far as we can see, to return any affection bestowed on them. Monkeys and great apes can hardly be considered



FOOD AND FRIENDSHIP IN THE PARK: RAINIER, U.S.A., AND RICHMOND, LONDON

Feeding the animals in the park suggests to most people a less startling animal than a bear. Yet parties of tourists through the great Rainier National Park, Washington, U.S.A., where the wild life of America is preserved from the ever-encroaching influence of man, can feed bears from the seats of their charabancs The more homely picture (top) of a deer in Richmond Park, London, shows caution and tentativeness in every line of the animal's body as desire for food overcomes the shyness of one of the most timid of animals

AFTERNOON TEA WITH A LION AT THE TABLE

Even lions, suitably fed and treated, are trusted by some people who know and understand them. But in the case of the great carnivora—whose very name means flesh-devouring—the attitude of the animal to the man seems as though it would always remain a dangerously uncertain thing. The tamest lion may be accidentally hurt—perhaps stung by some insect—and will snap at the nearest living creature in a moment. And after this first taste of blood no one knows what may happen in the mind of a hitherto quiet and inoffensive lion.

domesticated animals, yet individuals have been domesticated and have proved intelligent and docile, and sociable and affectionate, in their relations with man. Chimpanzees are particularly easy to domesticate and are almost human in their behaviour and moods. Agassiz confessed he "could not say in what the mental faculties of a young child differ from those of a young chimpanzee," and Mr. R. L Garner, who for many years made a special study of monkeys and apes, had a very high opinion of the character of chimpanzees. Writing of his favourite chimpanzee, "Moses," Mr. Garner says: "Not only was he tame and tractable, but he was never tired of caressing me, and being caressed by me . . . From the second day after we became associated he appeared to regard me as one in authority. He would not resent anything I did to him. I could take his food out of his hands, which he would permit no one else to do. He would follow me, and cry after me like a child, and as time went by his attachment grew stronger and stronger. He gave every evidence of pleasure at my attentions, and evinced a certain degree of appreciation and gratitude in return. He would divide any morsel of food with me, which is, perhaps, the highest test of the affection of any animal. I cannot say that such an act was genuine benevolence, or an earnest of affection in a true sense of the term, but nothing except deep affection or abject fear impels such actions and certainly fear was not his motive.

"There were others whom he liked and made himself familiar with; there were some he feared and others he hated, but his manner towards me was that of deep affection. It was not alone in return for the food he received, because my boy gave him food more frequently than I did, and many others from time to time fed him. His attachment was like an infatuation that had no apparent motive, was unselfish and supreme."

ANOTHER chimpanzee, "Aaron," proved "gentle and humane" and apparently "prompted by the same motives of kindness and sympathy that move the human heart to deeds of tenderness and mercy."

But, of course, all chimpanzees are not paragons, and Aaron's wife Elisheba was "treacherous, ungrateful and cruel in every thought and act, she was utterly devoid of affection; she was selfish, sullen, and morose at all times; she was often vicious and always obstinate; she was indifferent to caresses and quite

as well content when alone as in the best of company."
The other great apes—the orangs and the gorillas—seem much less tameable, and the various families of monkeys vary much in their capacity for domestication, but none of the apes and monkeys seem naturally hostile to man; and their attitude is more often an attitude of trepidant suspicion than of actual hatred or antipathy.

Another animal which has been domesticated in rare instances is the seal; but it is certainly one of the most intelligent, affectionate and teachable of animals, and in these respects must be placed with dogs, elephants, monkeys and apes.

ALMOST the whole Order of Birds, as might have been expected, is wild. With the exception of the various barnyard birds, of the ostriches, and of birds like canaries and parrots, kept in cages, they live a wild free life and their attitude towards man is hostile, as in the case of eagles, or timid as in the case of sparrows. A few wild species can be tamed so far that they will eat from the hand like caged birds. Most of them are attracted to human abodes simply by food, and when food is scarce they become specially tame. In some cases man has encouraged the semi-domestication of wild birds for particular reasons. Various species of hawks have been bred for hawking, and many wild birds are tolerated because they destroy slugs and worms or because of their song, and in Egypt, for instance, pigeons are protected as sources of manure. Among half-tame birds may be mentioned the robin, the swallow, the martin, the sparrow, the wood-pigeon, the barn-owl, the crow, the mallard, the magpie, the jay, the bluebird, the oriole, the vulture, the hoopoe, the mynah, the swan, the peacock. But such birds are only *half* tame and never learn to trust man, and despite the rich emotional potentialities shown in song and plumage, birds never seem to have any emotional attachment to man.

WHEN we regard really wild animals we find that man usually does produce a distinct reaction either of fear or of anger; but often the reaction seems to be acquired and not innate. In many cases it is man's own hunting habits that make him feared, and until they have had practical experience of man's dangerousness many animals do not show any fear of him at all.

As a rule few animals except bulls, and sharks, man-eating tigers, and lions attack a man without some provocation, and when a wild animal does attack a man without provocation, the impulse is usually fear or hunger rather than mere ferocity. Many animals indeed, popularly regarded as vicious and dangerous, do not attack without provocation. A snake inadvertently trodden upon will turn in wrath, and a lioness whose cubs have been stolen will attack the robber; but as a rule snakes and lions do not attack man. It may have required no divine intervention to save Daniel in the lions' den, and the stories of wild animals that have been cowed by the

There are some hundreds of thousands of species of animals, and it is an extraordinary thing how few of them have been domesticated, and that the most important of those domesticated are descendants of animals like the aurochs, that might seem untameable.

There can be no doubt that a little enterprise and patience could domesticate many more wild creatures. Many birds, such as the heron and stork, could be added to the barnyard, and many new animals could be added to the paddock. The elephant, with all its fine qualities, is hardly used, mainly on account of its huge size, but it should not be impossible to breed a much smaller race. The great apes, though they have intelligence and enormous muscular power, are deficient in docility; but the psychical differences between ape and ape even of the same species are very great and such qualities as docility could be easily selected in breeding

THE monkeys are usually mischievous and frivolous, but they have energy and activity, and they show constant variations, so it should be possible to breed a race of monkeys useful for agricultural or industrial purposes.

Whether apes or monkeys will ever be bred on a large scale in order to be used for rejuvenating purposes remains to be seen.

There should be little difficulty in domesticating seals, otters, and beavers; and it should not be impossible to train otters, seals, and pelicans for fishing, and to breed crocodiles for leather. In countries where termites are a plague, they might be cultivated as we cultivate oyster-beds. They multiply so rapidly that they can be gathered with a spade. Fried or grilled, they are said to be delicious and delicate eating, and have been compared to sugared marrow, to sugared cream and to paste of sweet almonds. Already we hear that they are sold as food in Java markets.

Again, the esculent swiftlet whose gelatinous nests are so much esteemed by the Chinese, might be protected and bred. They are birds that evidently multiply rapidly, for in Canton alone 25 million nests are annually sold.

Man can make his selection from almost the whole of the animal world, for almost every animal fears him and respects him and is willing to do his bidding, and not only has he choice of almost all animals at present in existence, he has power by scientific breeding to modify them to suit his purposes. There must be many possibilities of domestication still unexploited.

A E Smith

WHY THE HOUSE FLY IS HARD TO HIT: EYES WITH 4,000 LENSES

On the heads of flies a close inspection will show two hemispherical lumps, one on either side, and these are the flies' eyes. The microscope will reveal the fact that each of these masses rather resembles a jewel with an apparently uncountable number of facets. Actually, there are about four thousand of these little divisions and each is a separate lens. By means of the micro-cinematograph it has been possible to demonstrate a portion of the eye of a fly so magnified that an object waved in front could be seen reflected, as it passed to and fro, in each lens.

Chapter XX

Eyes of Wonder and Eyes that are Useless

By S. T. Burfield

Senior Lecturer in Zoology, Liverpool University

We all pity the blind man, and in so doing pay tribute to the greatness of the gift of sight. Sight to the normal human being means the ability not only to distinguish between light and darkness, but also to detect variation in the intensity of light and to recognize the form and colour of surrounding objects. The human eye, endowed with these wonderful powers, is the most perfect organ of sight in the animal kingdom; but just as some human beings have imperfect sight—for example, in colour-blindness—so we find various grades in the power of sight amongst other animals, and in the organs responsible for this sense.

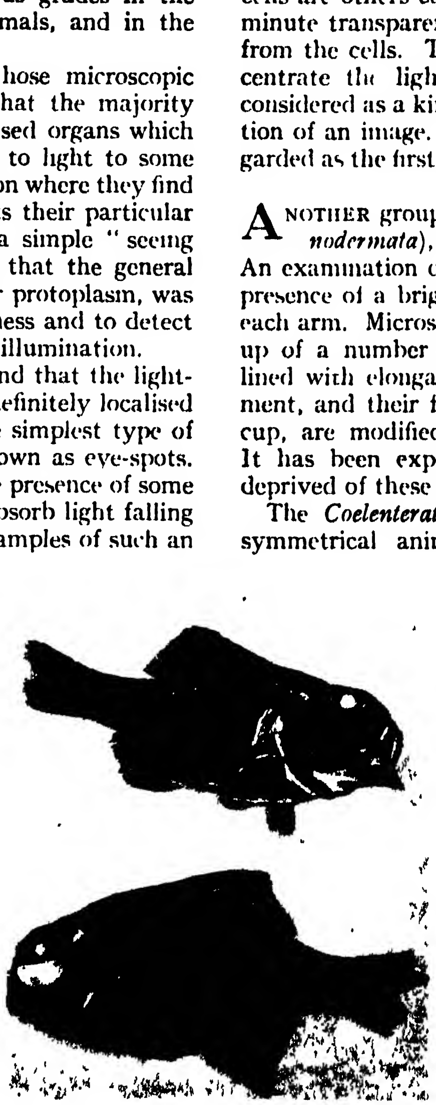
Beginning with the Protozoa, those microscopic specks of living matter, we find that the majority have nothing in the nature of localised organs which we could call eyes, yet they react to light to some extent, and tend to move to a position where they find the light of an intensity which suits their particular needs. In these cases we have a simple "seeing without eyes," and it would seem that the general living material of their bodies, their protoplasm, was able to distinguish light from darkness and to detect sudden variations in the amount of illumination.

In some protozoa, however, we find that the light-detecting power has become more definitely localised in the body of the animal, and the simplest type of "eye" is produced. These are known as eye-spots. These spots are distinguished by the presence of some coloured pigment which serves to absorb light falling upon it. One of the best known examples of such an eye-spot among the protozoa is found in the minute green creature (*Euglena viridis*) which often swarms in stagnant water. This animal is markedly sensitive to light, and the eye-spot consists of a tiny patch of red pigment situated near the front end of the tiny body.

Apart from the protozoa all animals have a body composed of large numbers of minute units of living matter. These units are called cells, and with this advance in general structure there comes the possibility of a cell or a group of cells in any part of the body becoming specialised for the better performance of a particular function.

The first of these "multicellular" animals to be considered are those which comprise the group *Coelenterata*, the jellyfishes and anemones being perhaps the best known of these. A well-known little freshwater member of this group, the Hydra, is sensitive to light, and will move to the window side of a glass jar in which it is placed, but no specialised cells for light-perception can be distinguished.

Many of the related jellyfish have collections of cells containing pigment, known as ocelli. At certain places on the margin of the jellyfish there are little groups of sense cells, from each of which a process runs inwards to a nerve network. Between these cells are others containing pigment. In some cases a minute transparent body is developed as a secretion from the cells. This probably merely serves to concentrate the light on the sense cells and may be considered as a kind of lens, though there is no formation of an image. Structures of this kind may be regarded as the first stage in the development of an eye.



Natural History, N Y

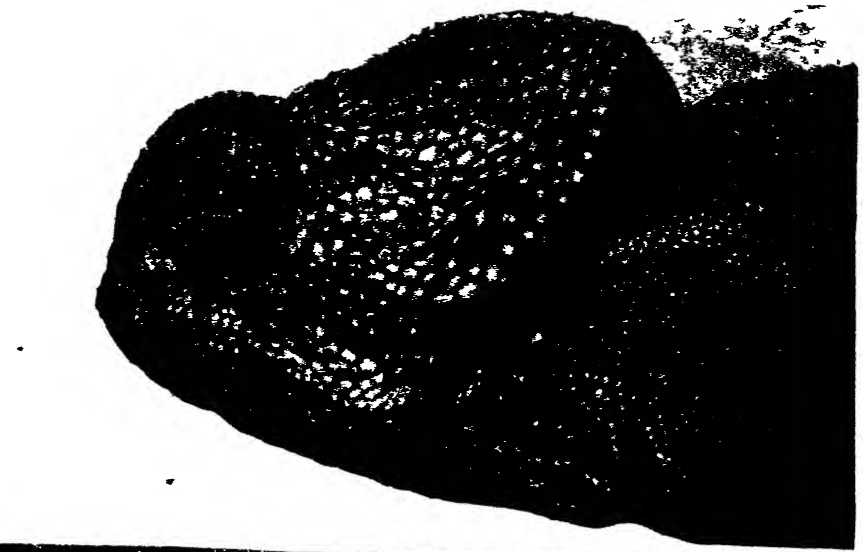
LIGHTED EYES

Off Banda Island swim the fish called photoblepheron (see also p. 212). They glide in and out among the coral lighting their way with their strange luminescent spots near their eyes

Another group of animals, the Spiny-skins (*Echinodermata*), also have eyes of this simple type. An examination of a common starfish will show the presence of a bright red or orange spot at the tip of each arm. Microscopic study shows that this is made up of a number of minute cups, each of which is lined with elongated cells. These cells contain pigment, and their free ends, forming the lining of the cup, are modified as clear, rod-shaped projections. It has been experimentally shown that a starfish deprived of these organs is insensible to light.

The *Coelenterata* and *Echinodermata* are radially symmetrical animals and their ocelli are correspondingly disposed. The next group to be considered, the Worms, have a more or less well-developed head, and the eyes are usually situated upon this as being the most useful position. A considerable number of animals differing a good deal from one another in structure and habit, are included within this group, and the condition of the visual organs shows corresponding variations. Nothing could be simpler than the eye-spots on the head of the common freshwater worm Naïs. Each of these consists of a single enlarged skin cell, alongside which are several smaller cells containing pigment. Other free-living worms have more complex eyes, for example, the common Nereis, found under stones at low tide.

In the most advanced type found in these animals a lens-like



Vonger and Marcher

A. E. Smith

ORGANS OF SIGHT AS THEY ARE IN THE TORTOISE, FROG, ELEPHANT, AND CHAMELEON

Man's eye is the most perfect seeing organ in all the animal world, being susceptible to an infinite number of the most delicate impressions But when we come to four-footed beings it should be remembered that what is considered a defect in human sight may be a special adaptation for the use of an animal in the individual circumstances in which it lives The variety in eyes is enormous The tortoise (bottom left) and frog (bottom right) have their eyes differently situated. While the elephant (top left) has, for its size, a minute eye, the chameleon (top right) has a comparatively large one In the latter case each eye works independently and is covered with a lid having a hole in the centre.

body is formed in the cup opening. It is improbable, however, that more than variations in light intensity are perceived by any of these. The best known of all the worms is the ubiquitous earthworm. This has no definite eyes, but careful work with a flash lamp at night will show that it is very sensitive to light, and it moves away from an illuminated area to the shadow. Moreover, it can easily be shown that the whole skin is sensitive to light to some extent, though this sensitivity is very much more strongly developed at the anterior end.

Among the animals dealt with so far we could find a series of eyes beginning with a simple patch of pigmented cells, passing through a stage in which the patch becomes cup-shaped, up to a condition in which the cup is nearly closed, and finally an eye in which a lens-like body is developed, closing the cup and serving better to concentrate the light on the sensitive cells.

J. J. Ward

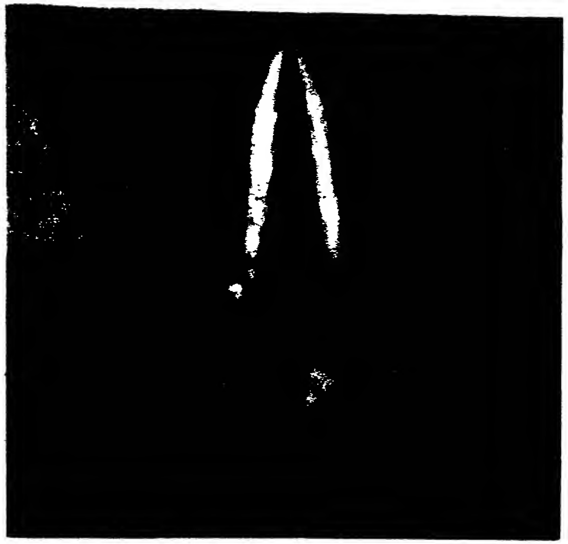
EIGHT EYES OF THE SPIDER'S FANGED HEAD

Usually the spiders are equipped with a group of six or eight ocelli, which are eye-like organs but of simpler and less developed construction than true eyes. To what extent the spider sees with its ocelli is hard to determine, for it relies very much on a highly specialised sense of touch. The lens-like skin which covers the ocelli is moulted periodically, causing a temporary blindness

The Mollusca, or Shellfish, a group of animals containing the snails, slugs, oysters, mussels, cuttlefish, and their allies, are of great interest in the matter of their eyes. Various stages are found among the different members, from a condition in which there are no localised eyes up to the complicated eye of the cuttlefish. Let us consider a few of the better known forms. The common English garden snail has two pairs of feelers or " horns " on its head. The second and longer pair have at their tip a small pair of black eyes. These are minute sacs, the walls of which are made of light-sensitive, pigmented cells, connected at their base with a nerve leading to the brain. The cavity of the vesicle is nearly filled with a horny lens.

In the freshwater mussel there are merely a number of pigmented papillae at the hind end of the body which are sensitive to light and shade. In the scallop, on the other hand, there is found one of the most complicated types of eye known in the Mollusca, with a well-developed lens and complicated double sensitive layer. There is no head in the mussel-like shellfish, and the eyes are situated on the margins of the fleshy mantle which lines the valves of the shell. This is the more usual position for light-sensitive organs in Mollusca with a two-valved shell. In the scallop there may be from about forty to four hundred of these beautiful organs, gleaming like little red jewels in the living animal as it rapidly moves through the water by opening and closing the valves of its shell.

There is one other type of mollusc that calls for notice. Anyone who has seen a living squid or cuttlefish would be struck by the almost human aspect of the pair of very large eyes situated one on each side of the head. Closer examination reveals the fact that these eyes are not only large but have a very complicated structure and are probably the most perfect form of eye found in the lower types of



Large White Butterfly

Gad-fly

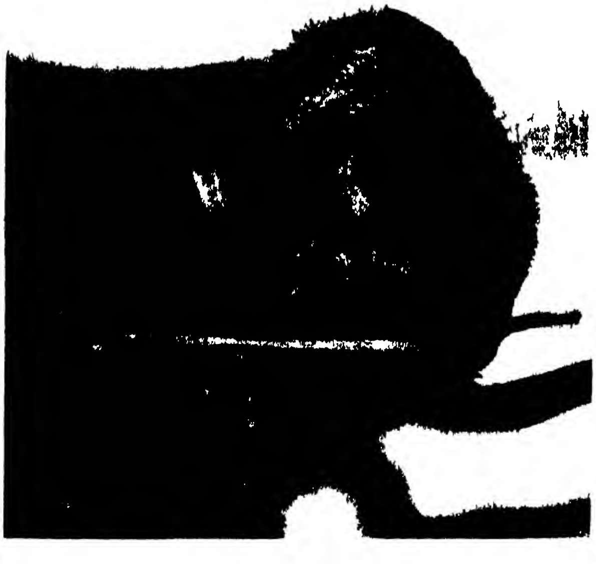
Lacewing Fly

WONDERFUL EYES OF MANY LENSES WITH WHICH SOME OF THE INSECTS SEE

The compound eyes of insects are built up in a wonderful way. The transparent external matter which covers the eye consists of a number of facets, in some insects numbering many thousands. Each of these facets gives a separate image of the object regarded. Below this external layer is a mass of corresponding facets, the surface of the true eye, which are really the upper ends of an equal number of columns which transfer the light messages to the nerves. It is thought that each facet registers an impression of a fragment of the object seen until the complete image is made up, as in a piece of mosaic, and conveyed as a whole to the brain. Further, such an arrangement gives a wide angle of vision for the avoiding of danger. Photographs by J. J. Ward

animal life. Their development is interesting because in the individual animal the eyes pass from a simple type, such as we have seen in the snail, to the highly specialised form as found in the adult.

Before we deal with the type of eye found in man, there is a very large and important group of the lower animals possessing a peculiar type of visual organ which must be considered This is the Arthropod Group (Crustacea, Insects, Spiders, and so on), which possesses a very distinctive type of eye which can certainly perceive the form of objects and possibly also a certain amount of colour



EYES AND NO EYES

Dragon-flies have their eyes almost as large as their head (bottom) and some species have 20,000 lenses per eye The larva of the common swallow tail butterfly (top) has markings on its body counterfeiting huge eyes while the true eyes are in the head

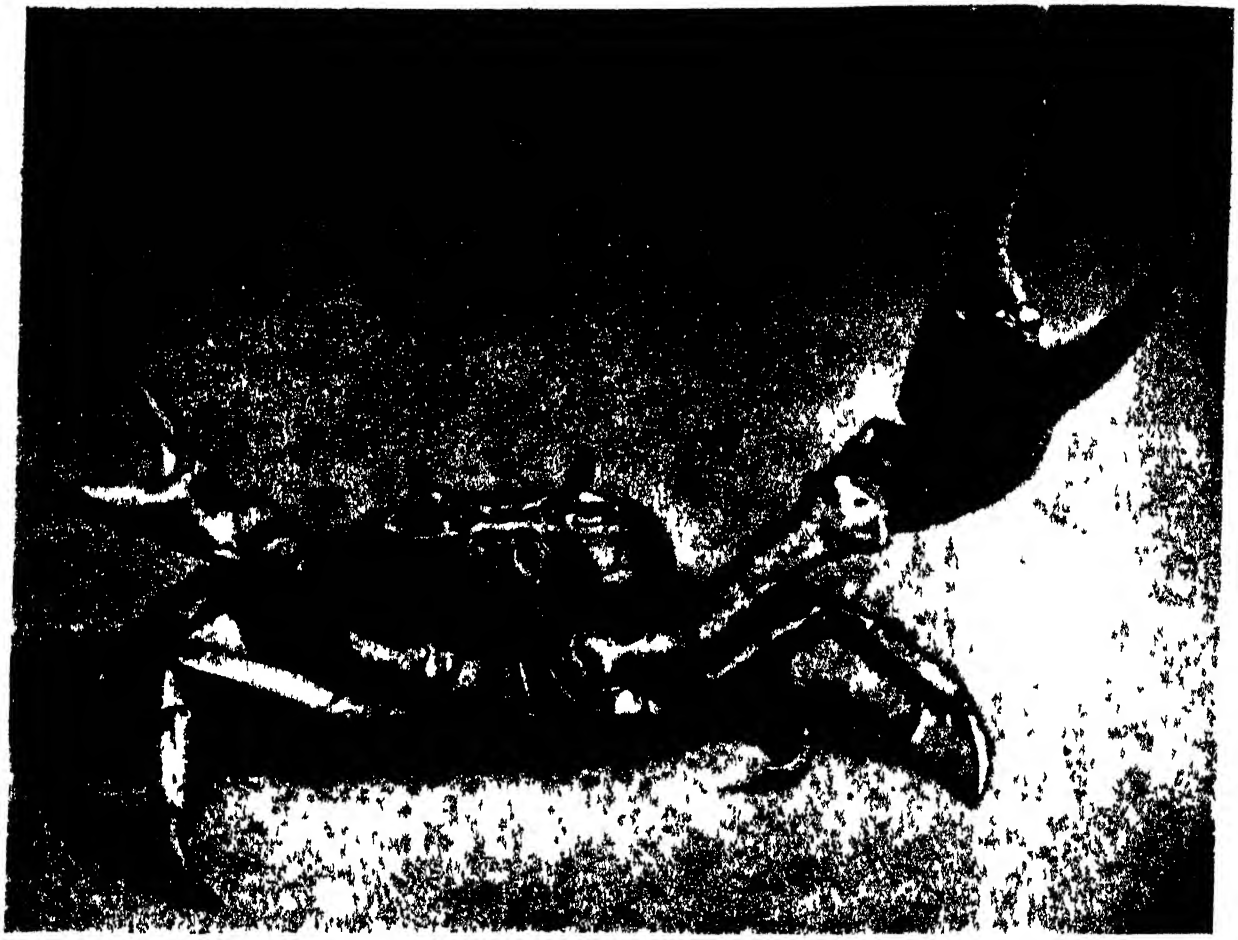
Two types of eye occur in this group, and in some cases these are both present in the same animal These two types are called ocelli and compound eyes respectively Perhaps the simplest type of ocellus is to be found in some of the smaller crustacea, and in the young stage of these, called the nauplius Here it is unpaired and is placed in the middle of the head One of the commonest of these small crustacea is found in fresh water and is called Cyclops.

The ocelli in these examples are of a simple type, a group of cells with a pigment mass, a nerve connexion, and usually a lens-like thickening of the skin which serves to concentrate the light to some degree In the large and important group of Insects ocelli are often found associated with compound eyes The common housefly and the bee, for instance, have three ocelli arranged in a triangle on the top of the head These ocelli have the general form of the type of eye we have found in many of the Worms and Mollusca There is a cup lined with sensory cells and pigment cells and a thickening of the skin to form a lens This is the only kind of eye found in the caterpillar stage of a butterfly or moth There may be as many as twenty of these eyes in some insects grouped on each side of the head

The Spiders form a group of animals usually detested by the average man, woman and child Closer acquaintance with these creatures, however, reveals much of remarkable interest They are certainly not sharp sighted nor long sighted, relying more on a highly-developed sense of touch in their dealings with the outer world, but they have eyes and these are very beautiful objects Situated on the top or front of the head region there is to be seen a group of usually six or eight of these organs shining like little gems The exact disposition of these varies greatly in different kinds of spiders but in all cases they have a structure essentially like that of the ocelli of insects

An interesting point in connexion with this type of eye is that the lens, being a part of the outside covering of the animal, is cast at the time of moulting and the animal is temporarily blind In the spiders it is said that the eyes do not all moult simultaneously Sometimes the eyes are not all of the same appearance some being black and the rest pearly white

Now we come to the compound eye, which is so characteristic of the Arthropod If we examine the head of any insect, such as a fly, a dragonfly, a butterfly or a beetle, we find that it consists largely of two great hemispherical masses often having a brilliant metallic lustre, perhaps green or purple These are the compound eyes If one of these be examined more closely with a hand lens, it will be



Neville Kingston

SPECIALISED PERISCOPE EYES OF A LAND CRAB

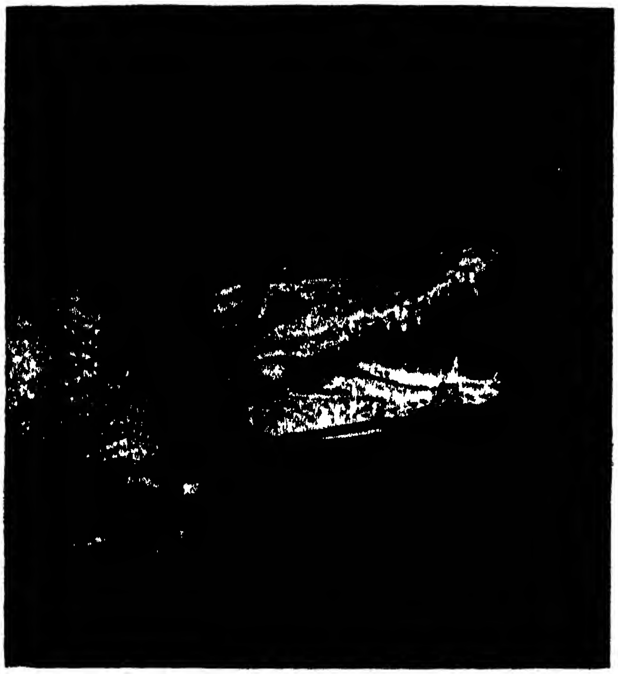
Among the several sorts of land crabs is the calling crab, so called because one claw is very much larger than the other, and with this disproportionate limb it makes brandishing gestures as though beckoning or calling to someone These crabs live in the sand on beaches, where they dig burrows for themselves At the mouth of these burrows they sit with their eyes projecting above ground like periscopes When this unusual looking crab is not on the look out these long eye stalks lie at rest along the front of the shell

seen that the surface is divided up into a number of square or hexagonal areas called facets These divisions are in the transparent external layer which covers the eye, but they correspond to a similar division of the lower layers, for the whole eye is really built up of a series of columnar units called ommatidia These units have a complicated structure, but each may be compared to an ocellus The compound eye in fact is believed to be derived from a group of ocelli

The number of facets (or ommatidia) in a compound eye may be very large, especially in some of the insects To give a few figures, the cockroach has eighteen hundred, the housefly has about four thousand the humble bee four thousand, whilst some dragonflies have as many as twenty thousand.

The mode of working of a compound eye is very interesting It is believed that in each ommatidium an image is produced by the light from an object or part of an object which is exactly opposite that particular ommatidium Thus with an object such as a stick only a portion is projected on the sense cells of each ommatidium, and the sum of the resulting images is built up into a single image which is transmitted to the brain Such an image may be compared to a mosaic built up of many pieces of one size

There is more in the story of the compound eye than this, however. In many crustacea inhabiting shallow water and in day-flying insects the pigment occupies different positions in the eye according to the intensity of the light In bright light the pigment surrounds the ommatidia, and a mosaic or "apposition" image is formed as already described On the other hand, in darkness or feeble light it has been found that the pigment blinds separating the ommatidia are withdrawn and the ommatidia do not now act separately, but a combined image is thrown on the sensory layer This is the "superposition" image. The eyes of many night-flying insects, as moths and fireflies, are permanently in this condition and are "day-blind." Butterflies, on the other hand, have the pigment permanently expanded and are in consequence "night-blind."



F W. Bond

Autotype

EYES OF THE CROCODILE WHICH NEVER SHED TEARS

To describe the tears of the hypocrite the phrase "crocodile tears" was coined, apparently from an ancient belief that the huge reptil was in the habit of weeping at the thought of the hardness of fate which decreed that it should have to kill animals for food Reallv, th lachrymal, or tear glands, are lacking altogether in the crocodile. Above are the eyes closed (left) and (right) a view from above of a crocodile's head, showing the eye coverings. In the bottom photograph we see the eyes of an alligator.

J J Ward

THE SNAIL WAKES

In this series of photographs we can observe how the snail's eyes function. The familiar "horns" are, when the snail is in its shell, like the fingers of a glove inside out. When the eyes are to be used the horns elongate as the glove-finger would when put on.

Among the insects the common whirligig beetle (*Gyrinus*) lives most of its life skating about on the surface of ponds and has its compound eyes each divided into an upper and a lower portion, the former being adapted for sight in air and the latter for sight under water. Thus this animal can keep a sharp look out for prey or enemies above and below at the same time. The males of some may-flies also have the eyes divided, one portion being raised on a pillar.

Contrary to what might be expected a great range of variation is found in the eyes of deep sea forms, which apparently are all living under similar conditions. Many stages are found from almost normal eyes to their complete absence. It is not easy to explain this, but a factor which must be taken into account is that a very large number of deep sea animals produce light themselves (phosphorescence), and a considerable illumination is doubtless present from this source even in very deep waters.

The Vertebrata include five types of backboned animals, the Fishes, Amphibia (frogs, newts), Reptiles (snakes, tortoises, lizards, and so on), Birds, and Mammals, or four-footed beasts. Man is placed in the last group. The structure of the eyes is very similar in all of these, so we may take the human eye as an example.

THE eye is a globular structure which lies in a protective socket in the skull. Within this socket the eyeball can be moved about within certain limits by means of some special muscles. The exposed portion of the eye is protected by two movable folds of skin, the eyelids. These folds are continuous with a very delicate transparent layer which passes over the exposed part of the surface of the eyeball and is closely adherent to this. This layer is the Conjunctiva, and inflammation of this membrane produces the condition known as a "blood-shot" eye.

The wall of the eyeball consists of three layers. Only the outer of these is continuous over the whole surface, but all three are perforated at the back to allow of the exit of the optic nerve. The outermost coat is protective, and over the front of the eye this layer becomes transparent and is here called the Cornea. The rest of this protective layer which can be seen from the front forms the "white" of the eye. The next coat, the Choroid, is thin and dark-coloured and contains a network of blood vessels. This layer is missing immediately under the cornea, but a curtain-like circular fold of it extends inwards all round a short distance behind the cornea. This fold, the Iris, has pigment on it which gives the colour to the eye. An aperture in the centre of the fold affords a passage for the light into the interior of the eyeball. This aperture is the Pupil. The iris contains muscles by which the size of the pupil can be altered. Thus the iris acts as a very perfect diaphragm, the size of the pupil opening being regulated according to the brightness of the light; the brighter the light the smaller the opening. In man the alteration in the size of the pupil is not under the control of the will as it appears to be in the reptiles and birds, and the

amount of alteration is also much smaller than in the cat and many birds, for instance.

Just within the iris is the Lens. This is a perfectly clear bi-convex mass, like glass in appearance. It is, however, not hard but may be slightly altered in shape. It lies in a very thin transparent membranous sac, which is closely applied to its surface. Around the edges this sac is continued as a sheet of tissue extending from the lens margin to the choroid coat. At the point of attachment to the latter the choroid is thickened, and from here to the sclerotic coat runs a series of muscle fibres, the Ciliary Muscle. The innermost coat of the eyeball is the actual sensory layer, the Retina. This is missing from the front portions of the eye, so that it has the form of a cup. The optic nerve running to the brain arises from the inner surface of the retina facing the lens, so that it perforates all three layers of the eye to get out. The cavity of the retinal cup and the space between the lens and the cornea are not empty, but are both filled with a clear substance. The latter space contains a liquid, the Aqueous Humour, whilst the retinal cup is filled with a gelatinous substance, known as the Vitreous Humour.

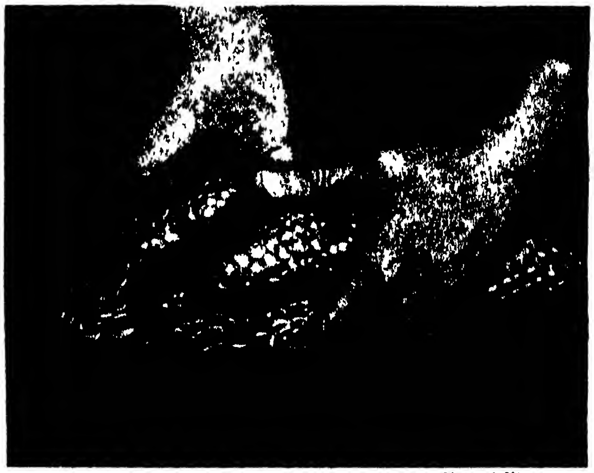
Some Vertebrates have an additional development in the eyeball layers. On the outer surface of the choroid in most fishes and some amphibia and turtles there is a silvery layer containing calcic crystals which extends on to the outer surface of the iris, giving this a silvery appearance. On the other hand, in some fishes and carnivorous mammals, such as the cat, and so on, the side of the choroid towards the retina develops a layer with a metallic lustre. This layer reflects light and is the cause of the eyes of these animals shining at night. This glow is due to some light entering the eye and being reflected to the observer. It may be pointed out that no animal can really "see in the dark." Some light is always necessary, as the eye is an organ for the reception of light from some outside source, though some animals have very sensitive eyes and are able to see in very weak light.

With this short description of the vertebrate eye we may now pass to some consideration of how it works as an optical instrument.

The eye may be compared to a camera, both consisting of two essential parts, a layer which reacts or is sensitive to light waves, the photographic plate or the retina, and an apparatus consisting of lens and diaphragm, or iris, which directs the light on the first part and focusses a sharp picture or image of external objects there. Anyone who has worked with a camera will know two fundamental things in the operation of this instrument: the image thrown by the lens on the back of the camera is upside down or inverted and, secondly, to make this image sharp and distinct, the lens is moved nearer to or further away from the plate according as the object is more distant or nearer.

In the vertebrate eye it is equally true that an inverted image is thrown on the retina by the lens.

Neville Kingston



Natural History, N.Y.

F. Martin Duncan

EYES ADAPTED FOR WATER

The common sepia (bottom) has large, almost human-looking eyes, while the turtle's (top) are adapted to its habit of lying all but submerged in the water. The Anaconda (middle) also lives much in water, and so has its eyes in the top part of its head.

Do we then see things upside down? The answer is in the negative, because an object may be considered as a collection of radiants or points from which light is passing into the eye and forming a series of images on the retina, and these images are referred, as it were projected, outward each along its ray line. Thus each radiant point is seen in its correct position in space, and we really do see things erect just for the same reason that we see objects in their right places. But in another way, we reinvert the image of an object in the very act of external reference.

Neville Kingston

A THIRD EYELID IN OPERATION

Among the birds the eyes are equipped with a third eyelid called the nictitating—that is, "winking"—membrane. This is drawn rapidly upward over the eye at need. The upper photograph shows a golden eagle's head with the eye open. Below is a crane with the eyelids still open but the membrane drawn over the pupil.

The second point mentioned above with reference to the camera was the focussing of a sharp image on the sensitive plate. In the eye we must also have a sharp image of the object focussed on the sensory cells of the retina if we want to see distinctly. The power of focussing a distinct image of objects at differing distances from the eye is called Accommodation, and it is brought about in different ways in the various Vertebrate groups. Apparently the lower types of fish life, such as the sharks, skates and their allies, cannot focus objects at all. The eye might do the focussing in the same way as the camera by moving the lens further from the retina for near objects and nearer to the retina for distant ones. This is the way in which accommodation is effected in the bony fishes and probably also in the Amphibia.

We could obtain a clear image on the plate of a camera in another way. Instead of moving the same lens nearer to or further from the plate we might change the lens without altering its position with regard to the plate, using a more convex lens for a near object and a less convex one for a more distant object. Accommodation in the mammalian, bird and reptile eye is brought about by a somewhat similar process. By the contraction of the ciliary muscle the lens is more loosely held by the supporting membrane. The lens is not hard, but elastic, and when the membrane which supports it is slightly loosened it becomes more convex. Now it is able to focus nearer objects on the retina. The nerve control of the ciliary muscle is very delicate and in the normal eye the convexity of the lens can be adjusted for objects at all distances. This wonderful arrangement is equivalent to the

possession of a whole series of lenses of different thicknesses. The normal human eye at rest is adjusted so that parallel rays of light entering the eye are focussed sharply on the retina This means that the eye is arranged to focus distant objects, in practice those beyond thirty feet. To see nearer objects clearly requires an effort, the muscular effort of accommodation, which can be quite easily felt if one looks at a distant object and then quickly at something quite near.

Let us conclude this article by noting the principal variations in eye structure which are found among the various types of Vertebrates.

In the Fishes the eyelids are poorly developed, or altogether absent, and the eyes are kept moist with water. The lens is peculiar and is specially adapted for vision under water. It is denser than in land animals and is nearly spherical. Both these qualities give it greater refractive power, which is necessary on account of the medium in which these animals live. The cornea is also very flattened. There is no ciliary muscle, so that fishes cannot accommodate by altering the shape of the lens. The eye is passively adjusted for near objects and they probably accommodate for distant vision by drawing the lens back nearer the retina, as mentioned above.

MANY of the fishes from the deep sea are blind, but some have relatively enormous eyes, often elongated so as to appear cylindrical like telescopes. These probably can make use of "phosphorescent" light as is also the case with some forms of the deep-sea Crustacea. Blind fishes are also to be found in underground streams in caves, such as the River Styx of the Mammoth Cave in North America. All these blind forms make up for the loss of the sense of sight by having an extraordinarily acute sense of touch.

Whilst buying any of the common flat fish, such as plaice or sole, many must have noticed the curious, twisted appearance of the head and the odd way in which the eyes are placed. The story of this twist is very fascinating. The very young fish has the more ordinary fish shape like, say, a herring, with one eye on each side of the head in the usual position. As it grows up the fish becomes deeper bodied and then tends to lie on one side on the bottom. Thus, one eye would become practically useless lying on the mud or sand. This eye now moves round the head from beneath to what is now the acting upper surface of the fish, and during this movement some of the head bones and also the mouth become twisted.

There is nothing special to say about the Amphibian eye except to note that the accommodation is brought about as in the fish, and that the lens is nearly spherical as in that group.

There are several points of interest in the Reptilian eye. In many reptiles not only is there an upper and a lower eyelid, but a third lid (the nictitating membrane) is present as a transparent sheet which can be drawn across the eye from the anterior angle. In snakes this membrane is permanently drawn across

Thomas Fall

REFLECTING EYES

Cats cannot see in the dark. There is some light in what is usually called "the dark," and the cat's eyes reflect that light from a layer of matter, round the eye-ball, which has a metallic lustre Hence the shining eye-balls that we so often see.

the eye and the upper and lower lids are absent. In the lizards and turtles there is a ring of small plate-like bones embedded in the outer protective coat of the eyeball. In the reptiles, as in birds and mammals, we also find various glands developed under the eyelids which produce watery fluid for the lubrication and cleaning of the exposed portion of the eyeball. One group of these are called the lachrymal or tear glands These are lacking from a few reptiles—including the crocodiles! Crocodile tears are, then, non existent.

Birds, as is well known, have very keen sight and their eyes have several peculiarities The iris varies in colour from the more common brown of the mammals, and may be yellow or red or even white. The rings of little bones in the protective coat of the eyeball, which were noted already as being found in some reptiles, are present in all birds These radiate from the margin of the iris and fit together so as to slide over one another slightly. They may be made to squeeze the ball so as to help accommodation for clear vision of very near objects.

The nictitating membrane is well developed and on watching a bird's eye closely it may be seen from time to time drawn upwards over the eye as a semi-transparent membrane. The shape of the eyeball is peculiar. The posterior part is hemispherical. Then follows the central portion shaped like a truncated cone and, finally, a hemispherical corneal region The eyeball is thus somewhat telescopic in its shape.

Finally, a few words about the Mammals. The general description of the structure of the human eye already given would apply substantially to the eye of any mammal. There are, however, a few points worth noting. The upper and lower eyelids are present, but the nictitating membrane is reduced to a rudimentary fold at the inner angle of the eye. The iris is most usually of a dark chocolate brown colour, due to a similar pigment to that present in the choroid coat of which the iris is a continuation. This, then, is probably the original and normal colour of the eye. The blue and grey eye are the result of peculiar structure and deficiency of pigment. A well known exception to the brown colour among the mammals is the yellow iris which is characteristic of the cat tribe.

The pupil in man and many other mammals is a round opening, but in two large groups the cat tribe and the grazing animals, the oxen, sheep, and so on, the pupil is greatly elongated. In the smaller cats it is lengthened vertically and in the grazers horizontally. The larger cats, such as the lion and tiger, have round pupils. The whales also have a horizontally elongated pupil and an extremely thickened outer protective coat to the eyeball. It is also interesting to note that in these animals the cornea is flattened and the lens nearly spherical, both of these being adaptations for seeing in water, just as we have noticed in the case of fishes. The eye in whales is relatively very small and is often placed low down on the side of the head near the angle of the mouth. From the position and comparative immobility of the eyeball it would appear that the whale has a small radius of vision. In a whale seventy feet long the eyeball measures about five inches in diameter. Among the better-known four-footed beasts which have a relatively small eye is the rhinoceros, and this animal has poor eyesight. The eyes are very much reduced in some

Neville Kingston

mammals which are nocturnal or burrowing forms. In the moles there may be a fusion of the lids, but in the mole-like form of Australia (*Notoryctes*) there is no lens and no differentiation of the two outer coats of the eye. The retina also is feebly developed. The group of bats also have poorly developed eyes, but, as in other similar cases, these blind or semi-blind forms have a very acute sense of hearing or smelling, or there may be an extraordinarily acute tactile sense as appears to be the case in the bats themselves.

UNUSUAL EYES

The rhinoceros lives a life where long vision is unnecessary, and is thus very short sighted. Also the eyes are placed, not near the ears but, near the snout. The hippo (top) has eyes in the top of its head, so that it can almost submerge itself in water and yet see

We leave the subject of eyes by mentioning a structure developed on the top of the brain in Vertebrates called the pineal body. In some lizards this is a small vesicle lying just beneath the skin on the top of the head, connected with the brain and having an extraordinary similarity to an unpaired median eye. Whatever may have been the function of this body in past ages, there is no conclusive evidence that it subserves a light-perceiving function in any living form. The French philosopher Descartes believed it to be the seat of the soul.

Chapter XXI

Living Lights in the Animal World

By F. Martin Duncan

Librarian to the Zoological Society of London

AMONG the many marvels of Nature none is more remarkable or dramatically striking than that strange power, possessed by certain members of the animal world, of producing during the hours of darkness that wondrous shining radiance termed phosphorescence, and thereby transforming themselves into veritable living night-lights; burning with a pale intermittent glow, or brightly scintillating like flashing meteors through the warm darkness of a tropic night, or turning the depths of the sea into a fairy realm—shining with a light that gives out no heat; burning with a flame that does not consume.

Although this wonderful phenomenon may be observed, in varying degrees, in almost every division of the Animal Kingdom, a careful analysis shows us that it attains its highest development among the forms of animal life that inhabit the sea; indeed, the only vertebrate, or backboned animals, having true light-producing organs, are to be found among species of marine fishes. On land the power of phosphorescence, or luminescence, which is really a better word to use, for these strange natural fires have nothing to do with phosphorus, reaches its maximum among certain species of insects; the light that has occasionally been observed on the breast and thighs of the heron and on the plumage of the owl being due to the presence of luminescent bacteria, and not produced by the birds themselves.

Naturally the function and importance of these light-producing organs in the life of animals have been subjects of considerable speculation and controversy. But despite much theory and a certain amount of careful and practical experimental work, knowledge cannot be honestly said to have advanced very far; much still remains to be ascertained, more particularly in its bearing on the life of the animal and its environment. The chemist may be able to tell us that luminescence in certain groups of animals is the result of the interaction of two substances to which he has given the names luciferin and luciferase, in the presence of water and oxygen, but that does not help us very far along the road to the solution of the puzzling question of why in two closely related species, which we may for simplicity call A and B, and both apparently leading similar lives in a similar environment, species A possesses well-developed light-producing organs, while species B shows, so far as can be ascertained, no trace of them at any stage of its life whatever.

F. M. Duncan

TROPIC FIREFLY

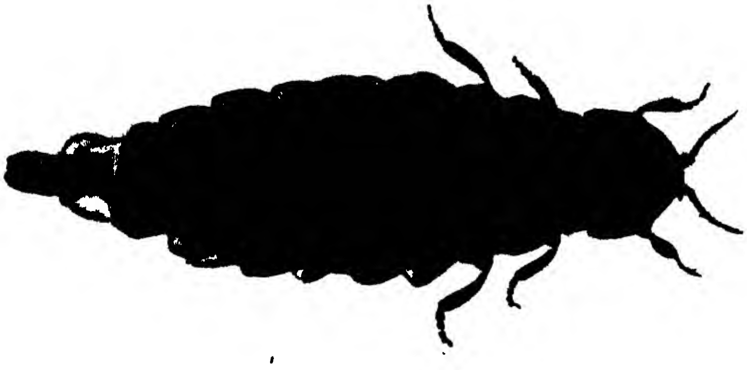
Glowing green and red like jewels in the tropic night, fire flies are often used by women in South America and the West Indies as ornaments for the hair. The fire "fly" is really a small beetle.

WHILE it may perhaps be right to suppose that metabolic factors, the chemical changes taking place in the living tissues, have played a not unimportant part in the history of luminescence, a closer scrutiny of these light-producing organs and the discovery during recent years of tissues actually serving as lenses and reflectors, would seem to place beyond doubt that such highly developed organs must function for the projection of light in very definite directions, indeed have become natural searchlights; and that in their presence we are faced with a biological problem of far greater importance and significance. That the marine fishes in which these most highly developed luminescent organs, complete with lens and reflector, are found, use them as searchlights there can be little doubt, though for what particular purpose, whether for alarming foes, attacking prey, recognition of their own kin, or for visual help in locomotion through their dim water world is, indeed, far less certain.

The surface waters of the sea are, at certain seasons of the year, densely populated by minute and very varied forms of life, collectively known to the student of marine zoology under the term Plankton, and actually forming the primary source of food supply to the bulk of our marketable marine fish. One of the chief factors that will determine an abundant or a poor harvest of mackerel or herring off our coasts, is the abundance or scarcity of these floating organisms. They are a strange assemblage; many belong to the simplest forms of animal life, the Protozoa; others are the young or larval stages of molluscs, of marine worms, and of various species of crabs, starfish and sea-urchins, together with adult crustaceans,

and jelly-fish or Medusae of all sorts and sizes ; and a large number are phosphorescent to a greater or less degree.

On a still, warm summer night every rippling wave as it breaks upon the shore sparkles and flashes with gleams of silvery light, and a fishing boat slowly gliding across the bay leaves a fairy trail in its wake, at every dip the oars scintillating as if surrounded by liquid flames. Far out in mid-ocean, particularly in the warmer tropical and sub-tropical seas, these phosphorescent displays become more intense and awe-inspiring No one who has had the good fortune during an ocean voyage to witness what sailors sometimes call a "milk-sea" could ever forget the mystery and beauty of so marvellous a sight. The night is intensely dark, only the stars faintly gleaming in the immense dome of the heavens, while the good ship appears to be sailing mile after mile through a sea of molten silver, the swell breaking against her sides like sheets of leaping, bluish tinted flames.



If we were to lower a glass jar over the side of the ship we should find, on hauling it inboard, that the water with which it is now filled sparkles with myriad points of light that flash out into brighter phosphorescence every time the jar is shaken. In the well-lit cabin we should no longer be able to watch this pyrotechnic display, but we should be able to detect the presence of a number of little, somewhat oval, transparent specks of jelly, not much bigger than a fair sized pin's head, moving rhythmically through the water as if propelled by some unseen force. Our jelly-speck is really a perfect little member of the Protozoa, known as the Noctiluca, and though scarcely measuring one twenty-fifth of an inch in diameter is really a giant of its kind, most of the Protozoa being almost, if not quite, invisible to the naked eye. Seen under a microscope the Noctiluca appears as a tiny crystal globe, rather like a peach in shape, its delicate surface marked with a fine net-work that reminds us of the veining of the skin of a white currant or a gooseberry. Down one side there is a slight indentation in which the mouth of the tiny creature is hidden away, and from a point in this depression arises a short lasher or flagellum, the hidden force that propelled the little creature through the water when we watched it in the jar.

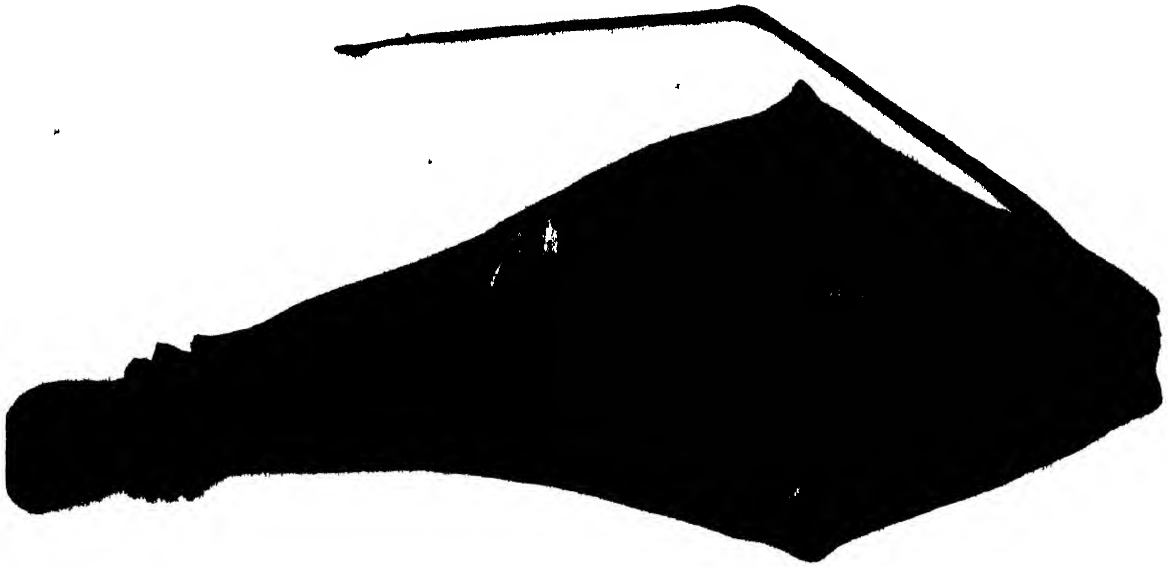
When the surrounding water is agitated, the Noctiluca glows with a bluish or greenish phosphorescence. The light is not constant, but appears and disappears rhythmically, almost like the revolving light in a lighthouse, and is apparently emitted from a number of minute, slightly opaque points scattered over the body of the tiny animal. When the Noctiluca is excited, these points first shine out, the light quickly spreading and suffusing the whole of the transparent little body with a brilliant luminosity. So bright is the light produced that a glass test tube fifteen millimetres in diameter filled with a mass of phosphorescent Noctilucae will illuminate the face of a watch sufficiently to enable one to read the time when held at the distance of a foot away.

J. J. Ward

GLOW WORM, THE FIREFLY'S EUROPEAN RELATIVE

Male glow worms have wings and look like beetles (bottom), but the female of the species (top), which emits the softly shining light of opal tint that is so familiar, is wingless and looks like a grub. The light comes from a number of spots on the abdomen and is used to attract the male in the darkness.

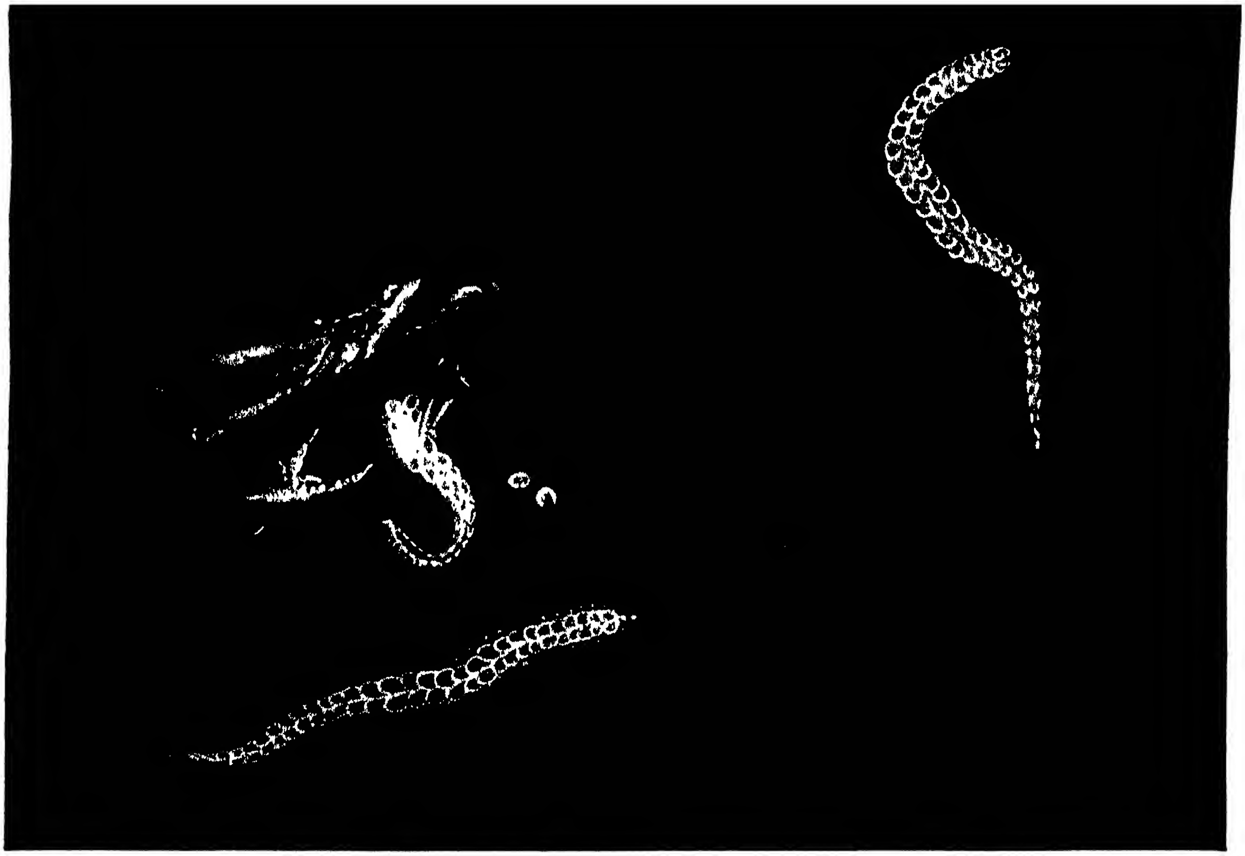
Many of the so-called jelly-fish, the Medusae, are brilliantly luminescent, and it is a wonderful sight on a warm summer night that is revealed when we



W. S. Berridge

ANGLER FISH WITH LUMINOUS BAIT TO CATCH THEIR PREY

Deep down, far below the slightest influence of sunlight, live these two ugly fish which have evolved a light generating apparatus for the purpose of picking up a living. The melanocetus (bottom) is known—and very justly, if appearances count for anything—as the sea devil and is famous for its dreadful teeth. The upper photograph shows us another of the angler fishes which has a lump on the end of its "line" that shines in the dark depths attracting other fish within reach. It is found in the East Pacific at a depth of about 770 fathoms.



Natu al History, N.Y.

EXTRAORDINARY PROTECTIVE MEASURE ON THE PART OF A DEEP-SEA WORM

The power of giving out light is found in some of the worms of the sea. In this illustration we have the scene, constructed from scientific research, enacted when a crab seizes a luminous worm, cutting it in two with its claws. The captured piece of the worm lights up and wriggles, thus distracting attention from the other end which remains unlighted an l so escapes. Two of the worm's luminous scales are seen floating near the crab. This and the succeeding illustrations in this chapter are from scientific drawings in the journal of the Franklin Institute.

lean over the side and look into the quiet dark water as the boat slowly passes through a shoal. Lit up with their cold, greenish or bluish fires the Medusae rise out of the inky depths of the ocean and pass by, their " umbrellas " gently pulsating, and their long tentacles streaming out behind like the tails of a comet. In some species the whole surface of the disc or umbrella is illumined ; or the luminescence may be confined to the upper part of the disc, or to the fringing tentacles. Sometimes on a dark night the edge of a sandy shore will be outlined in pulsating phosphorescent gleams, due to hundreds of these jelly-fish being washed up by the tide.

MOST of the Ctenophora, the so-called Comb-bearing jellies, are vividly phosphorescent at night, while in the daytime they glisten with rainbow-tinted iridescence caused by the rhythmic beat of the comb-like bands of cilia by means of which these frail, crystal-like creatures propel themselves in the sea.

These comb-bearers are wonderfully active little creatures, and at certain seasons of the year they literally swarm in the surface waters of the sea, while thousands are left stranded on the shore by the ebbing tide. The so-called Sea-gooseberry (*Homiphora plumosa*) is a very common species on our coasts, and is about the size of a hazel nut, and looks very like a small, glass gooseberry encircled by eight regularly spaced bands of cilia. The little creature is also provided with two long and extremely contractile tentacles, which stream out in graceful curves as their owner slowly moves through the water.

Perhaps the most remarkable comb-bearer is the Venus's Girdle (*Cestus Veneris*), common in the Mediterranean, and also found in the Atlantic. It is quite unlike the rest of its relations in appearance, for they are all more or less globular in form, while the Venus's Girdle resembles a long, delicate ribbon of an exquisite silvery blue hue, and may measure over three feet in length. It moves through the water by graceful undulations of its long, slender body rather than by the movement of the combs of cilia which are grouped along the edge of the ribbon and gleam in the sunlight with a wonderful violet-tinted iridescence. At night these luminous living ribbons are a very lovely sight.

Among the swarms of minute animal life floating in the surface waters of the sea are various species of small Crustacea called Copepods, which are highly luminous, and are at times present in such large

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SHRIMPS AND PRAWNS LIGHTING UP THE WATERS AS THEY SWIM

Parts of the bodies of certain shrimps (lower drawing) emit a radiance giving them a strange appearance as though they were ships with rows of portholes through which light was shining from within. These strangely equipped crustaceans are shown swimming in and out among the seaweed. In the upper illustration are some deep-sea prawns which, instead of lighting themselves, discharge heavy rings of opaque luminous substance brightening all the water above them. These clouds rather resemble smoke puffed from a pipe.

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LUMINOUS SQUIDS THAT SWIM DEEP DOWN IN THE SEA OF JAPAN

Phosphorescence—or rather the phenomenon so called, for it has nothing to do with phosphorus—is a most complex matter when its occurrence among the marine animals is studied. While some creatures no doubt use their power of illumination in order to see their prey and others, like the angler fish (page 207), have developed it into a highly specialised lure, yet some fish use their light in a way which one cannot explain on these lines The deep-sea squids can light up different parts of their bodies as will be seen by a study of this picture.

numbers as to produce long trails of phosphorescent light. The luminosity produced by these active little Copepods is secreted by special glands on the surface of the body, and is due to a substance having the property of becoming luminous on coming into contact with the water when issuing from these glands. Whatever the chemical action thus set up may be, it is not dependent upon the living tissues, for these luminous Copepods have been collected and dried up completely, yet still retained their luminous character; a steady glow being given off when the dried, dead specimens were placed in sea-water.

There is a very interesting little shrimp-like Crustacean called *Meganyctiphanes norvegica*, which is common at no great depth off the British coasts, and can be kept in an aquarium where its pyrotechnic displays can be observed. If the room is darkened, and the glass jar containing the creature is gently tapped, the luminous organs along the sides of its body will flash out like a row of miniature portholes on the side of a ship; the light shining brightly for a few seconds and then gradually fading out, only to appear again directly the tapping is repeated.

Certain Molluscs (shell-fish, as they are often called) are luminous, such as the beautiful little Pteropods of the surface plankton, and the burrowing Pholas that bores its way into rocks on the floor of the sea. While the Pholas conceals its light so that it gleams only faintly from the opening of its tunnel, the little Pteropods, or wing-footed molluscs, are veritable fairy ships, that add their share to the luminescence of the surface waters.

There are many species of Crustacea that live at great depths, far below where the last faint gleam of daylight can possibly penetrate, and while some possess light-producing organs, others do not, but from their large, well-developed eyes obviously are not condemned to grope about in perpetual darkness. Many deep-sea animals are known to be luminous, and probably the large-eyed forms profit by the phosphorescence of these fire-flies of the deep. There is, for example, a deep-sea Hermit Crab (*Parapagurus pilosimanus*) which lives at depths of at least two thousand fathoms, or two nautical miles, in partnership with a colony of sea-anemones which it carries about with it, and probably it is able to see its way about by the light emitted by the anemones, which in return for acting as head-lights receive a share of the banquet when the Hermit dines, capturing the floating fragments of the feast by means of their tentacles. There is also a deep-sea Prawn (*Heterocarpus alphonsi*) which ejects from the orifices of special glands at the base of its antennae, or feelers, copious clouds of bluish phosphorescence that has been seen to be of sufficient intensity to illuminate a bucket of water in which the prawn had been placed so that "all its contents were visible in clearest detail."

That certain regions of the great depths of the ocean are not areas of total darkness would now seem

to be clearly established as the result of recent oceanographical investigations which have proved that not only the Prawns and Crabs (*Crustacea*) but the Sea-pens, Starfishes, worms and many other invertebrate forms dwelling at these great depths are brilliantly phosphorescent; so that the floor of the sea must present an appearance perhaps analogous to a fairly well-lit street at night, with its alternate patches of bright illumination and heavy shadows.

Phosphorescent organs are highly characteristic structures in many deep-sea fishes belonging to widely different families, and vary very greatly in their complexity, number, and mode of distribution. Usually they are found on the sides and ventral surface of the body and head, more rarely on the upper surface. In *Stomias* and *Pachystomias* there are two rows of phosphorescent organs along each side of the body that present the appearance of a chain of brightly glistening jewels set in the skin, while *Pachystomias* has luminous organs beneath its eyes. The family Scopedae contains many deep-sea forms remarkable both for their weird shapes and complex luminous organs. One member of this family which is not known to occur at great depths, will be familiar to many readers who are partial to curries, for in its salted and dried condition it is known as "Bombay-duck." The scientific name of this fish is *Harpodon neherens*, and when freshly caught it is brilliantly phosphorescent all over its body. Large numbers are caught, salted, and dried, and exported from the west coast of India. A near relation is found in the Indian Ocean at depths of 120 to 300 fathoms.

The angler-fish or fishing-frog (*Lophius piscatorius*) has a very interesting deep-sea cousin, the sea-devil (*Melanocetus murrazi*) which lives on the floor of the sea at depths of over two thousand fathoms. Like the shallow-water angler-fish of the British seas, this sea-devil has a wide mouth well armed with incurved teeth, a huge head, and tapering body. On the top of its head this uncanny-looking fish has a long fishing-rod tentacle that hangs over its mouth, and at its free end bears a luminous bulb that serves as a phosphorescent bait to attract small fishes and other creatures to their doom.

The whole question of the phosphorescence of marine animals is a very complex matter, and the part that it plays in the life of the animal would appear to differ with the individual. In the clouds of luminous secretion thrown out by the deep-sea prawn described above, and by the surface-dwelling Copepods it may serve, like the inky cloud thrown out by the cuttlefish, to baffle pursuers. In some cases it may serve as a lure to attract prey in much the same way that a lamp attracts moths and other insects: while the more complex luminous organs would seem to serve to illuminate objects coming within the range of vision. In others, again, it may be of help to individuals of the same species to keep together in a swarm or shoal, or serve as recognition marks by which they may find their mates. But the function of luminescent organs is not always that of giving light for their possessor to see by, for many luminous animals are blind. In these cases, however, it has been noticed that elaborate complex luminescent organs are not present, the animal only exhibiting a diffuse glow, or giving off luminous secretions.

On land the most important light-bearers are the fire fly beetles of the tropics, and the glow-worm beetle of the British countryside. On warm summer nights, particularly in the south and west of England, the glow-worm beetles shine out from the hedgerow and banks of the country lanes like tiny fairy lamps. The little creature has gained its popular name of glow-worm from the wingless, long-bodied female, which is much more luminous than the winged male. At every stage of its life, egg, larva, pupa, and adult, this interesting little beetle whose scientific name is *Lampyris noctiluca*, is luminescent; the amount of light shown increasing with its growth, and reaching its maximum in the adult female in which the lighting apparatus occupies the last three segments on the under surface of the body. In the winged male the light organ is confined to the end of the body, and is visible on both the upper and lower surfaces, whereas the two large belt-like organs of the female shine under her body, only the smaller spots on the end of her body being, as in the male, visible from above.

Watching the unlovely grub-shaped female crawl over one's hand in the daylight, it is impossible to realize how these large luminescent organs can be

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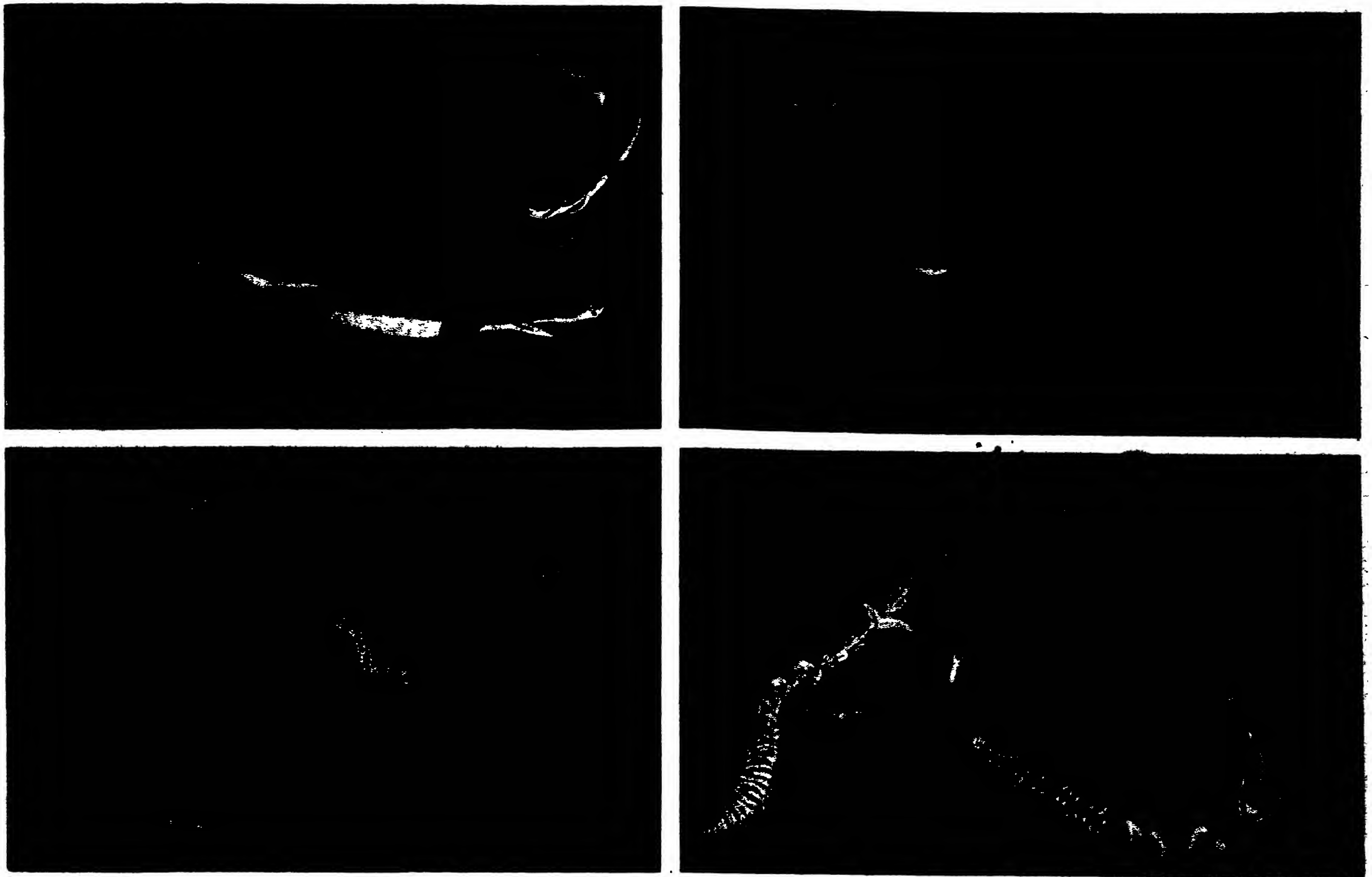
SHINING JELLY-FISH OF THE MEDITERRANEAN

Many of the jelly-fish are phosphorescent or rather luminescent, to use the more accurate term. In the Mediterranean it is sometimes possible at night to watch mysterious companies of these things rising, with an increasing glow, from the outer darkness of the sea. Our illustration shows some lighted and some unlighted



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DOWN IN THE DEPTHS OF THE SEA WHERE AN EERIE LIGHT IS SHED BY SWIMMING THINGS

Some, among the marine worms (bottom left) spend most of their life in crannies in the coral, but in the summer rise to the surface, where the female becomes luminous and attracts a mate. The chaetopterus (bottom right) lives in a tube. Eels are very partial to it, and here we see an eel which has bitten off the end of the tube and is dragging chaetopterus out. A neighbour, disturbed by the commotion, is "lighting up," and even the one being devoured does not cease to shine. There are luminous sharks, too (top left), found at depths of 500 to 1,500 fathoms. Their light comes from thousands of organs in their skin. Another fish (top right), found off Banda Island, cannot stop its light shining, and so has a curtain of pigment to draw over it.

of service for attracting the male from a distance, for that is their essential function. Under natural conditions, the little lady glow-worm remains more or less quiescent during the daytime, but on a warm, dark, summer night she will ascend the nearest grass stem and proceed to indulge in violent gymnastics, twisting the tip of her flexible abdomen in every direction, so as to expose to view the two broad bands of luminescence on the under-surface of her body; and it is in this way that she sends forth her nuptial signals, flashing out across the darkness of the night like Hero's lamp to guide her approaching mate.

The fire-fly beetle of tropical America (*Pyrophorus noctilucus*) attracted the attention of the earliest travellers, who were so impressed by the wondrous display produced by hundreds of these insects illuminating the forest glades that detailed descriptions occupy a prominent position in all the accounts written by the old explorers The *Pyrophorus*, or cucujos, as it is called in Brazil and other parts of tropical South America, is really a cousin of the small but notorious agricultural pest of our fields, the so-called click-beetle, for both belong to the family *Elateridae*. The cucujos, however, is much larger, and has brilliant phosphorescent organs, two that are oval in shape on the upper surface of its body, placed one on each side of the thorax, and a third on the under-surface of the abdomen. The light given out is extraordinarily brilliant, and the natives capture these fire-flies and literally use them as living lanterns to light them on their way on nocturnal excursions through the forests.

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LOWLY ORGANISMS WHICH BURN BUT ARE NOT BURNT

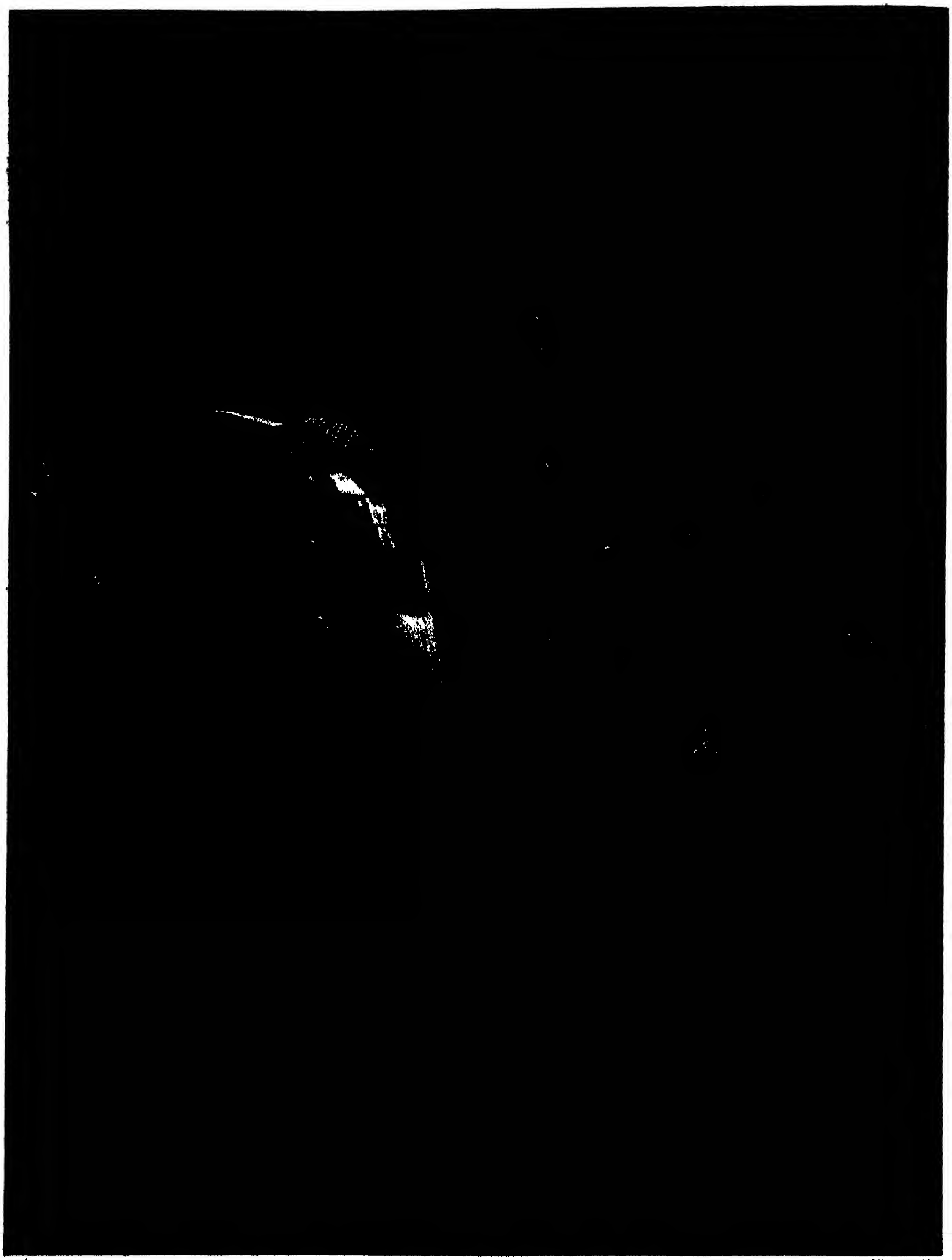
There exist in the sea certain living organisms known as dinoflagellates, and their name signifies that they move themselves by whirling a small whip like tail These creatures are on the border-line where the highest plant life and the lowest animal life meet. Like the other "living lights" they produce light by the oxidisation of a substance called luciferin, which is secreted in the protoplasm of their body cells

THERE are certain species of bacteria which are luminescent and, although apparently harmless, occasionally produce rather startling results Salted haddock and other dried fish occasionally light up the family larder with a phosphorescent glow, which is no sign of putrefaction or being unsuitable for food, but is merely due to a very vigorous growth of those luminous bacteria.

The whole problem of the purpose and use of luminous organs as found in the animal kingdom is an exceedingly complex and difficult one, and still offers a very wide field for original observation into the habits and environment of the light-bearer, and for further microscopical and biochemical research in the laboratory of the expert.

To what extent luminous animals are ever likely to be utilised to the service of man is an equally problematical question True, the tropical fire-flies have for centuries been used as living lamps and even for adornment by the natives of the West Indies and South America, while the Banda islanders utilise the luminous organs of a fish called *Photoblepharon*, as a bait for their night lines in fishing. Civilized man, so far, has only turned the luminous bacteria to practical account, Beijerinck having used cultures for the testing of bacterial filters, a perfect filter allowing no organisms to pass through, while Dubois has made phosphorescent "lamps,' using luminescent bacteria for the purpose, which might be of value for illumination in high explosive magazines where any heat-producing source of light is a danger But the use of any luminous animals for practical purposes of illumination would appear to be very doubtful. Perhaps some day the biochemist may discover the secret of the fire-fly and from that knowledge ultimately develop a really efficient light for the use of mankind

In the exquisite beauty and mystery of these luminescent displays, as in all the beauty of Nature, Man has a treasure which in this mechanistic age he seems ever less and less able to appreciate, fouling the surface of the sea with the black, death-spreading, wasted oil from his ships, and the countryside with the garbage of the town. In the summer the picnicking motorist has been responsible for fires that have destroyed thousands of acres of heather and gorse in Surrey, Sussex, Hampshire, and other southern counties, where the glow-worm also had her home, and will never again display her fairy light



Oliver G. Pike

KINGFISHER FINDS A GOOD PERCH WHENCE TO DIVE FOR ITS PREY

A commanding position over the water is what the kingfisher seeks when fishing. A post or any projecting object in the water will do, or a reed or, as here, a root exposed by the swirl of winter floods. In this case there is deep water under a sheer bank, and here, out of the current, a shoal of fry—small roach or bleak—will sooner or later appear. Then the bird makes a dive like the flashing of blue lightning, disappears a moment under the water and, in the same second, flies up with fish in beak. Sometimes, however, the bird will hover.

Chapter XXII

The Marvels of An English Brook

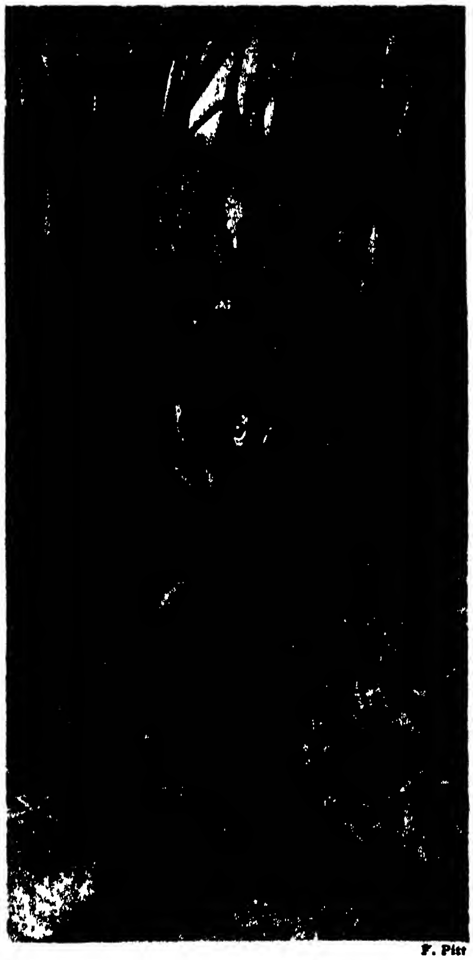
By Sir William Beach Thomas

Author of "The English Year"

In the pleasant land of Britain many hundred brooks run down to the rivers and the seas. Towards the west, where the hills are many and steep, they flow fast and free, with a merry sound among the stones. In the south, where the chalk lies beneath they are crystal clear. Towards the east they are more leisurely and wander more like the Lea which, as one of the earliest poets wrote, "oft doth lose its way." But all these brooks, however much they differ in character, have very much in common. Not many animals and not very many plants and insects are peculiar to any one stream. What is true of the inhabitants of one brook is true of most of the others.

Most brooks grow steadily bigger as they come nearer to the sea, but sometimes no part is more spacious and lovely than the source, as on the Pang in Berkshire, where the water comes bubbling out of white chalk and sand, over which the biggest trout lie, for mere pleasure of the feel of the fresh water; and a little lake half covered with heart-shaped water-lily leaves is rounded out before the brook is formed and starts on its journey to the Thames. Almost all water is fuller of life than the land. The best time to observe the wonder of the teeming population is in May or earlier, when the insects we call flies, though they are not properly flies, are wonderfully changed from water creatures into air creatures.

Both caddis flies and mayflies appear mysteriously in myriads at the surface and as they reach it pause for a second or two before they can open their new wings and take flight. It is then that the struggle for life is most apparent, and you see how the water creatures are dependent on one another. The fish are less numerous than the flies, but they are in shoals in most of the bigger brooks. When May comes, they grow hungry, and a scarcely visible swirl in the water indicates how some spotted trout or silver dace—the chief devourers of these flies—has caught its food on the way to the surface. Sometimes the fish jumps right out of the water in its eagerness for food. The mayfly are called the ephemerids, or one-day flies, though they often live longer; and very soon after their escape into the air and the wedding flight they come back to the water to lay their eggs, which are stuck together like little rafts, but soon sink to the bottom. Very often the mayfly who lays them is drowned. In some years, thousands may be seen floating downstream. But many of these apparently dead flies are only cases, for these ephemerids on first appearance cast a skin that covers the whole of their frame, wings and all; and this is so perfect that often it is scarcely to be distinguished from the living fly itself.



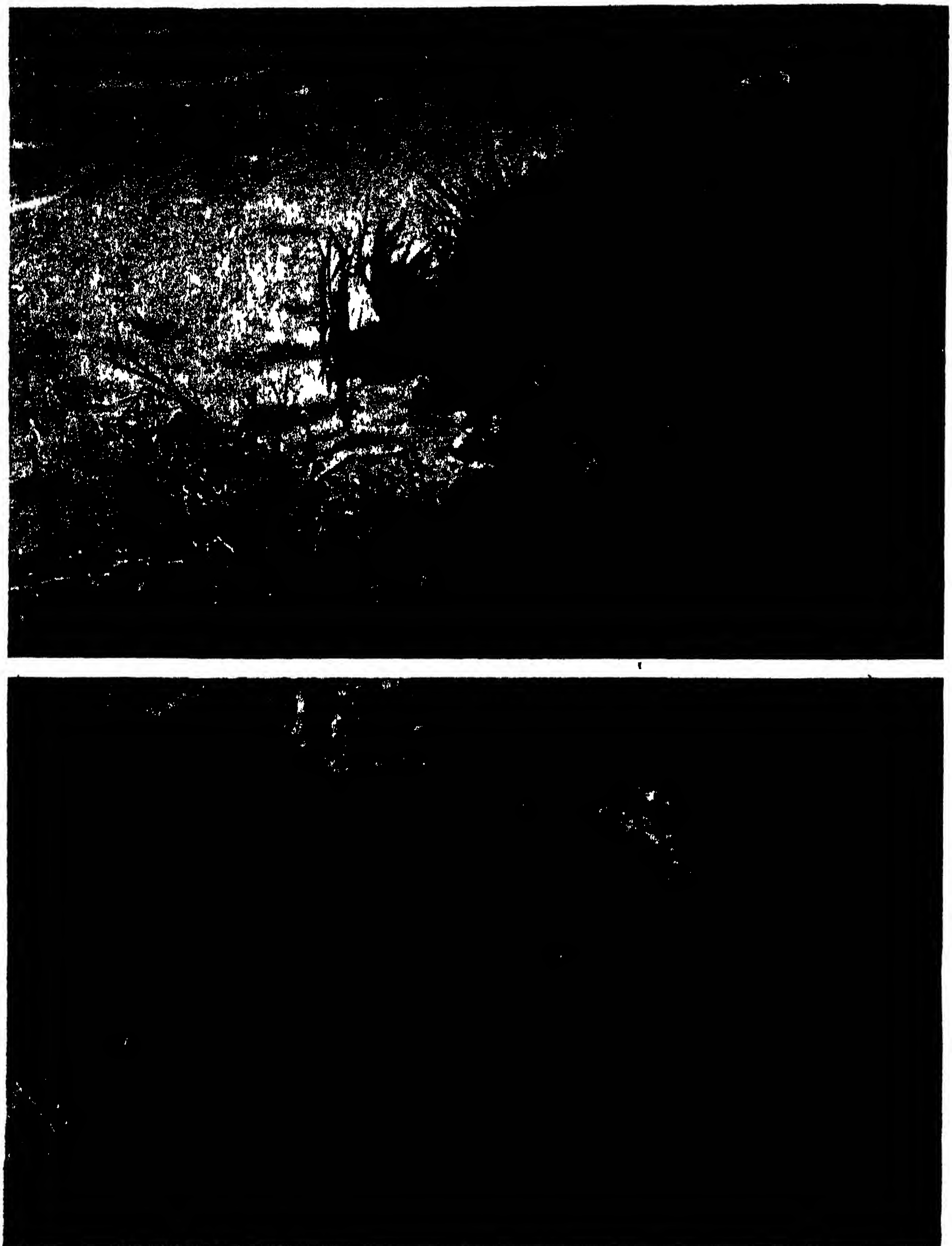
F. Pitt

LITTLE WATER-VOLE

Living in the banks of the brook in a tunnel which has one entrance above the water and another below it, the vole can often be seen quite close by keeping still. It is also called "water-rat"

All through the spring and summer and early autumn births of this sort may be seen. Among the latest in the year, waiting till autumn, are the dragon-flies which laboriously climb up the stems of water plants and go through the marvellous change in the sunlight while they hang on to a stem or leaf. Both before and after the change they are among the most ruthless hunters of all water animals. The animal from which they come is the terror of the floor of the stream. He crawls about for the year or two of his life seeking what he may devour; and the queer mask-like mouth is a marvellously efficient instrument for his purpose. His nearest rival in greediness is the big Dytiscus beetle, which often comes to the surface to breathe and carries down with it a drop of air which it carries under the tail of its case. It will attack even small fish.

Most caterpillars and other creatures that creep and crawl eat voraciously, and the perfect insects into which they change enjoy the sun and air with little thought of food. The perfect mayfly, itself the favourite food of trout, does not feed at all. Its



C. Reid

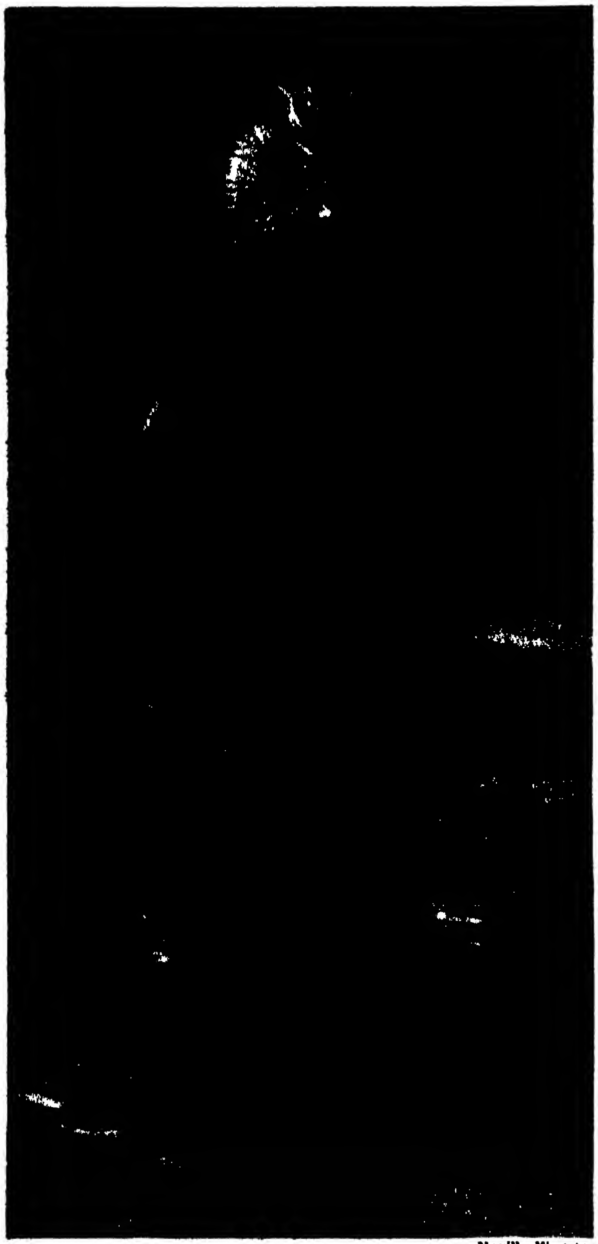
SHYEST AND LEAST OFTEN SEEN OF WATERSIDE ANIMALS: THE OTTER

While the footprints of the otter are sometimes to be remarked in the soft mud by the water's edge, the animal itself is very rarely seen. The reason for this is that the otter lies snug during the day in its lair, which is tunnelled out of the bank of the stream, sometimes under the roots of a tree. Furthermore, it is only the least frequented parts of the streams that otters seek, and it should be remembered that they are hunted. Occasionally an otter shows himself in daylight as this one, photographed as it was about to enter the water.

C Reid

OTTER AS IT MOVES IN AND ABOUT THE WINDING ENGLISH BROOK

Many people, especially those who stock streams with trout or preserve salmon water, regard the otter as a pest merely But there i another opinion which holds that in the delicate "balance of Nature," whereby one animal preys upon another, the otter has its place For, as in the case of pike, it is usually the weaker fish that get caught, and weak and sickly fish are better out of the way for the sake of the species. At the same time it is exasperating to find a fine trout left with just one piece bitten out of it



Neville Kingston

OTTER AT PLAY

One interesting fact about the otter is its love of play. All sorts of antics are performed in and out of the water, and sometimes a family will make a slide down some steep bank and career into the stream one after the other time after time.

form does not permit. The dragon-fly on the other hand springs dragon-like on other winged things, catching them in its queerly-shaped fore-legs, which serve it almost as hands both for this purpose and earlier in clinging to the reed or other water plant while it steps from its shell.

One of the most curious differences between some of these water insects and the land insects is that they do not go through the three different stages of larva or grub, pupa or chrysalis, and winged creature. The dragon-fly, for example, leaves out the middle stage. The grub grows by shedding its skin and passes into the so-called nymph stage without ever becoming still and half-lifeless like the ordinary chrysalis. It passes from the stage of nymph to the imago or perfect insect by slipping off its case directly it leaves the water. The dragon-fly takes the longest time, and unlike the others, must rest some while after escaping from the case before the wings expand to full size and grow hard and brightly coloured in the sun.

The caddis fly on the other hand goes through all the stages in its year of life. The eggs fall to the bottom and the grubs are hatched. They then make themselves cases out of little bits of sand, pebble, stick, or what not, which they fix together by a sort of gummy silk. The grub is rather like a hermit crab. The part within the case is soft, and the part that projects and catches food is hard. When after many months it feels a change coming, it withdraws fully into its room and spins a silk barrier across the doorway, which remains closed till the next change is nearly complete. The larva or grub has become a pupa or chrysalis, and is about to become a winged creature. As soon as it is ready for the air it eats through the silk, with jaws specially constructed for the purpose, and comes to the top of the water as a " nymph." As it clings to some stem or weed the last change is wrought. The nymph case splits and out comes the perfect fly or imago, with four hairy wings and long antennae; and presently after mating, the female lays a mass of eggs held together in a jelly on the surface of the water. The cycle of life is complete.

THE fish feed on the fly, as well as the crawling creatures of the stream, but they are themselves in no little danger. So immense is the number of eggs that a fish lets fall—often in a hollow scooped in the bed of the brook—that if half grew up, the river would be solid with fish within three years. Other fish eat the eggs; and both the fry that came to birth and the bigger fish have a certain number of active enemies.

The greatest enemy from outside the water is the heron, one of the biggest English birds. As Tennyson wrote in The Brook: " I come from haunts of coot and hern." Herons stand, as a rule, in shallow water among reeds, or sedge if possible, and abide as still as the plants, till fish or fly or rat or vole, or even a small bird comes within reach. They then strike with such amazing quickness that you cannot follow the movement, and they very seldom strike in vain. It is thought, though this is not quite certain, that they will eat also the fresh water crayfish, which are almost as numerous as water snails or shrimps in a few English brooks, though rare elsewhere. In one respect the kingfishers, brightest of brook birds, imitate the great grey heron. They keep astonishingly still, on their perch over the river, and when they see a fish below, strike with sudden speed. But they dive, just as an American fish hawk dives, to catch their prey, and seldom make the attempt unless the fish is at the very surface. The kingfisher

is more of a brook bird than the heron. It seldom leaves the neighbourhood of the stream, and nests in holes either on the bank or close by, often using fishbones in the structure. The slow beat of the heron's wings carries him long distances, and the heronries in which he builds, high up in lofty trees, are often in distant woods.

More powerful and ruthless than any other enemy of the fish is the otter, which, perhaps, is less often seen by human eyes than any of the bigger animals. Fishermen tell grim tales of its destructive powers. They find big salmon dragged to land, and know the otter for the culprit, because of the deep bites into the shoulder of the fish. But some preservers of fish in the north-west of England, which is the best otter country, claim that the otter, though he kills fish, does more good than harm. The fish is the better swimmer, and it is the fish that are suffering from some malady that the otter more certainly catches. So it comes about, they say, that where some otters are found there the fish are healthier; and though they kill some fish that the fishermen would like to kill themselves, the otters should be allowed their reward. What is called the balance of nature is a strange and sensitive thing, extremely perfect in Britain, and if we interfere with this dependence of one creature upon another we are apt to do more harm than good.

F Pitt

HERON ALERT

This is the fishing position of the heron, with long neck upstretched. The bird stands as still as a tree and becomes part of the landscape till suddenly there is a lightning movement and a fish is seen flapping in that beak which seldom strikes in vain

Oliver G Pike

HERON CONTEMPLATIVE

After feeding the heron stands serene in apparent contemplation, while the process of digestion takes place. In this posture no idea of the real length of the neck is suggested for it folds up between chest and beak. But at a hint of danger it is upstretched immediately.

The otter is a night creature. One often sees his footprint in the soft mud beside the stream, but seldom the living animal. A few people have seen also "the otter's slide." No animal is more playful, as those who have kept tame otters know, and in wild life a family will make a slide down a steep bank, like the slide in some public swimming baths, and career in a festive circle after one another—down the slide into the water and back up the bank to begin the game again.

The otter is certainly less deadly to fish than are some other fish, especially the pike. Pike are almost shark-like, with strong, sharp, teeth-like points. Many fish will swallow other fish not so very much smaller than themselves; few small fish are safe. Perch, which abound in some rivers, are an exception. They eat others, but are not eaten, thanks to the extreme sharpness of their fins. The pike have many things on their side in the struggle for life. They have their powerful and well-armed jaws, they grow very big, flourish both in still and running water, in pond or brook, and are immensely long-lived. No one quite knows how long their life may last, but they certainly survive, on occasion, more than the three score years and ten of human life. It is no wonder that the first step taken by those who preserve trout in our streams is to get rid of the pike;

F Pitt

Oliver G Pike

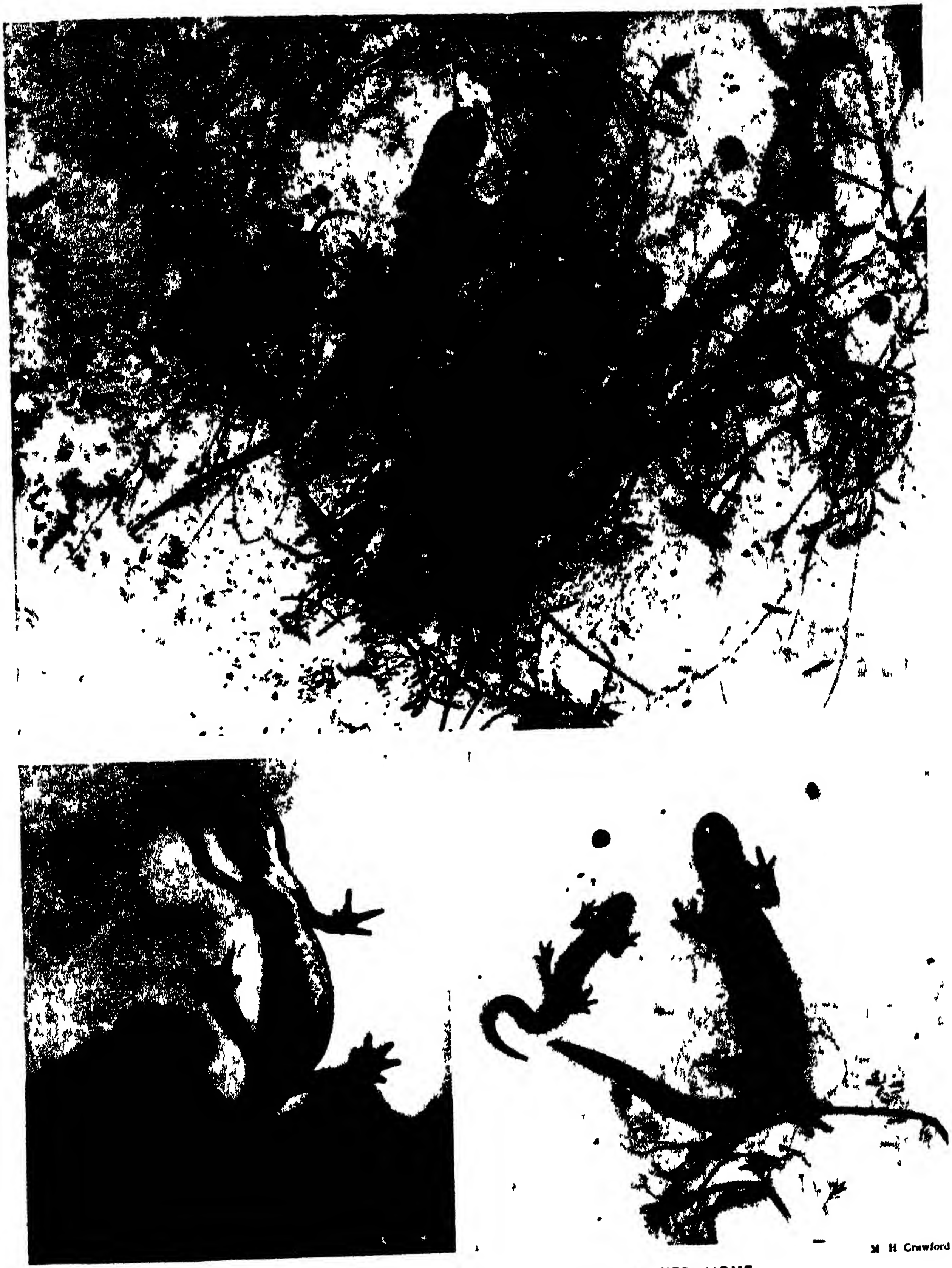
KINGFISHER AND ITS YOUNG

When it has secured a fish (bottom) the bird holds it crosswise in its beak, flies up to its perch, stuns the fish, tosses it up into the air, catches it very neatly and then swallows it head first. Above are some young birds preparing to shift for themselves

for the pretty, spotted, so-called brown trout, as delicately coloured as the imported "rainbow" trout, are a delicate fish, easily poisoned, and perhaps easier victims to their enemy than the thick-scaled dace or red-finned roach or perch

The pike, as well as the water rats, will eat many other water animals than fish. Even young birds fall victim. Few birds have flourished more or multiplied more than moorhen, but they lose many of the young to these two enemies. They build, as a rule, almost on the water, as do the coot and the dainty dabchicks, with which they are sometimes confused. The nests are not unlike, but the dabchick is more careful, and generally covers up her eggs with bits of reed or other nesting material when she goes away. The wild duck nests in safer places, further away from the water; generally on the ground, but sometimes in willow trees; and her chief cause of loss is the earliness of her nest-making. Often she takes her brood to the water while spring is so young that insect food is very hard to come by; and starvation is a real danger. If any enemy is threatened the young swim so close to their mother that they seem to stick to her. The young moorhen, on the other hand, generally try to dive, though when they are very young they can do no more than put their heads under. The light, fluffy bodies refuse to follow. The young dabchick can dive with great skill at once, and the bird is so fond of the water that it very seldom flies at all; and when swimming under water, for either food or safety, uses its wings as well as its feet. It swims on the surface smoothly without the quaint jerk of the head that marks the moorhen.

The brooks of the south and east of England are without one charming water-bird. The only small bird that is really at home in water and close to the water is called the dipper, or water ousel. Its nest is usually over or beside the stream, and though the birds are waders, not swimmers, they have been seen by good observers calmly walking along the bottom, though totally submerged for a short space. The dipper is as perky as a wren, but looks more like

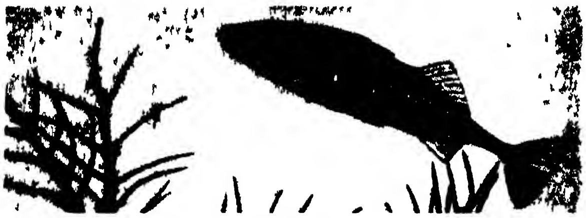


M H Crawford

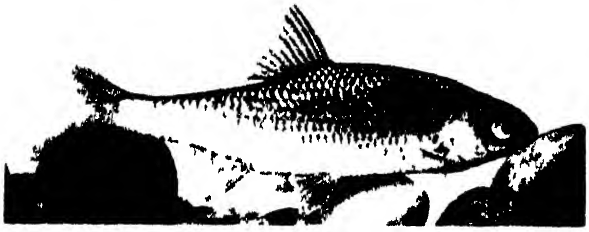
NEWTS AS THEY LIVE IN THEIR UNDER-WATER HOME

Beginning life in a fish like state with gills, the common newt (top) gradually develops lungs and becomes air breathing It spends much of its life, save in the breeding season, on land sometimes at a considerable distance from water, but always prefers damp surroundings It usually hibernates in the ground, but sometimes spends the winter in the water The under parts are spotted (bottom left) the tail is flat and coloured red and blue in the male, but red only in the female The last photograph shows a common and a crested newt or triton

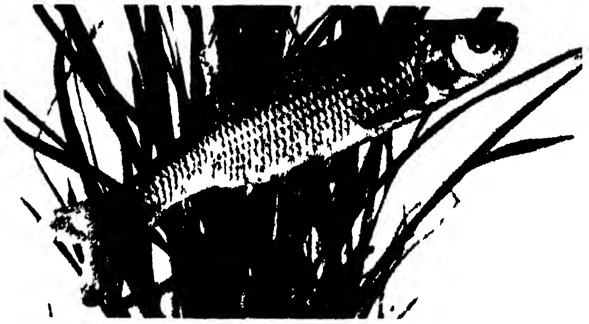
Minnows



Stickleback



Roach



Chub

Loach

FISHES OF THE BROOK

The loaches that Jan Ridd used to impale with a home-made trident in "Lorna Doone," the chub which lies right under the bushes along the bank, the roach with the lattice-work pattern on its back, the fierce little stickleback and the minnow, all swim the English brook. These photographs are by S. C. Johnson

a small blackbird that has turned white underneath. In the north-west of England, which is his favourite home, his low, sweet song may be heard even when there is snow on the ground.

The brook is often both a battlefield and a hunting ground, but many of its inhabitants are wholly peaceable. None is more charming to watch than the little water-vole, whose tunnelled house has two entrances at least, one below the other above the water. Almost like the dyticus beetle he can hold air. You may easily see the silver beads of it caught in his close fur, as he dives and swims below you. How bravely he goes about day after day finding reeds and sedge and water weeds, some for his food, some for his nest. He stays round about his home, and is in every way wholly different from his cousin the sewer or water rat, which is a destroyer of life and will travel long distances. This grey rat is a lustier and fiercer creature than the old black rat which has almost disappeared. But the vole was once known and is still often known as the water-rat, for the name vole is recent.

Though he is bigger and when closely seen very different in shape and structure, he may be mistaken by a casual observer for the water-shrew. Both live in holes on the bank of the brook and eat thus living in the water. But the shrew, like the land shrews, is a fiercer little creature living almost wholly on animal food. Everyone can recognize a land shrew at once by the astoundingly long, almost beak-like snout, but this feature is blunter and shorter in the water-shrew, easy enough to detect if the animal is in your hand but not as you see a flash of him swimming past you very fast under water to his home on the bank.

Some streams never seem quite so full of life as when the caddis fly and mayfly come out, and about the same date the frogs, toads and newts come back to the water. All these hibernate, that is, spend the winter in hiding and shelter; and both frogs and toads prefer the land to the water throughout late summer and winter. But in spring they make for the water in great numbers to lay their eggs. The frogs, which come first, lay their eggs in jelly-like masses. The toads, which come three or four weeks later, in long jelly-like strings, and the lizard-like newts, of which there are three sorts, more neat and careful in many ways, carefully wrap up their eggs in the fold of some water grass or weed. Perhaps one of the strangest things in natural history is the slow change of the tadpole of frog or toad with the gills of a sort of fish into a land creature with lungs; and it is the easiest to observe. One of the oddities is that the long tail of the tadpole is very slowly absorbed by the frog very much as part of the egg by the growing chicken. In the north-west of England is a "batrachian," as these creatures are called, which possesses a tail all its life, but this natterjack is rather surprisingly rare and local.

The newt has one curious likeness to another inhabitant of the water, much studied by children

It develops in spring brilliant red patches of colour round the throat. Now, if you look down into a brook in early morning, you may see a little silvery fish swimming round and round and to and fro ; and he catches your eye by the extreme brilliance of a scarlet patch. This is the male stickleback—probably the three-spined stickleback--guarding the female fish. He attacks any and every enemy that approaches ; and seems almost as angry against his spouse, for he at once chases her back if she attempts to leave her nest on the bed of the stream.

How the stream teems with life becomes obvious in spring, but a census would show that it is as great or perhaps greater in late summer. Births and deaths follow in endless succession. On the surface of a brook or pond in August, when they are most active, one may see what look like some hundreds of drops of quicksilver sliding about the surface in a mazy pattern, apparently with no particular aim or object These silver drops are little water beetles very fitly known as whirligigs. They have been well compared with the bats that will fly over the stream in numbers when the evening comes. Both turn and twist with a speed that baffles the eye and they have a like purpose. The bats pursue flying insects, the whirligigs the minute insects that are caught for a moment on the surface of the water. But for their speed of movement most would escape them. Very nearly all the water insects have some of their legs flattened into paddles, as you may see even from a distance with the great dyticus, which may be an inch and a half long, and rather less obviously in the great water beetle, which is sometimes a quarter of an inch larger still. In the whirligig, the back legs are paddles and the short front legs used, like the dragon-fly's, for holding the prey. Another insect, the water boatman, has yet more curious paddles, and he is so well hinged that he can propel himself while he lies on his back, which is shaped like the underside of a boat. So paddled, in this upside down position, these queer insects swim almost as fast as the beetles. The paddle is good and the friction against the water as slight as can be.

Some water beetles and bugs, however, do not need paddles. One in this class is the water scorpion, another the water stick-insect. The scorpion does not need paddles because it spends most of its time hunting along the floor of the water ; but it possesses wings, as do several other under-water insects, which use them only when the water dries up and they are thus forced to migrate. The stick-insect is perhaps so well known because of the brilliant patch of red which suddenly shows on his drab, crushed-looking but ample body when the wings are raised. He resembles in this the very common long narrow-bodied, sun-loving insect known as the Soldier, though he is in a different family The bugs and the beetles, which are two of the biggest classes, resemble one another in many details, in spite of many differences. The scorpion and the boatman are bugs (or Hemiptera). So is the large corixa, which has

Water Scorpion

Water Beetle

Corixa

Water Boatman Pupa

Pond Skater

Water Hog or Louse

QUEER CREATURES OF STREAM LIFE

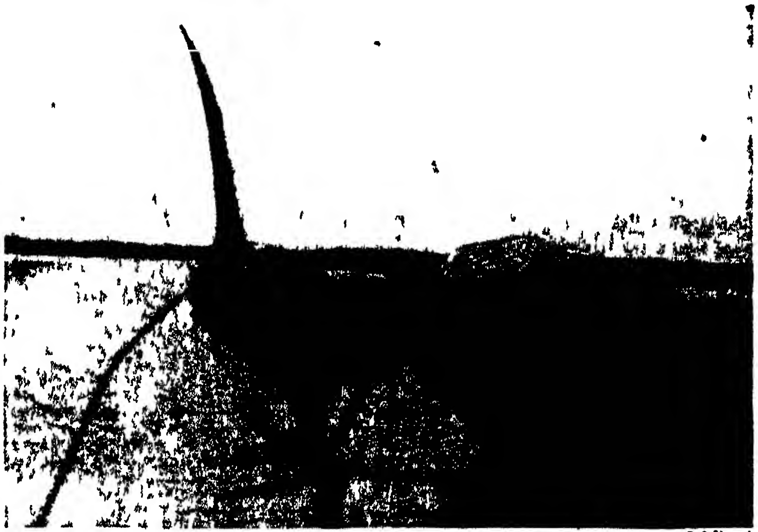
Many forms of brook life need more watching for than the fish The so-called " hog louse," for instance, lives at the bottom, while the more obvious boatman and pond skater are at the surface The water beetle and water scorpion are well worth studying, too The photographs are by M H Crawford and S C Johnson

the dark shiny green colour common to many beetles, but it lacks the regular hard wing cases and its mode of motion is very much like the boatman's except that it paddles itself the right way up.

The animal that most ingeniously adapts itself to a life in the water is not insect, mammal, fish or mollusc, but spider. Like the dyticus beetle and the vole it imprisons air in the hairs of its body, coming up to the surface to recharge itself. But it needs more air than this and weaves two sorts of nets to imprison supplies. One is for its nesting hours, the other for its winter quarters. The difference is that the first is closely woven above and is at first like a silk raft, and does not become rounded like a diving bell till the bubble of air is introduced below. The winter home is of rather closer silk and is enclosed all round and is usually anchored in a much better protected place, sometimes inside an old crock or bottle. The male which, unlike all other spiders, is bigger than the female, lives in an air chamber alongside, and when the time comes, eats through the division and the air bubbles join.

The brook, unlike the sea, has not very many molluscs, but those it has are curious. The fresh water mussel is the biggest of all the molluscs. It lives nearly all its time well under the mud, and is worth close study because of its queer construction. It possesses a siphon which it thrusts above the mud and by which you may trace its presence, and a yet more curious organ in its huge and powerful 'foot' which it advances even as far as three inches or more and pulls the shell after it, making a tunnel in the mud. The mussel is rightly called a mussel, but the water shrimp is not a shrimp in the sense of the sea animal, but rather more like the 'hopper' commonly found among stranded sea weed.

All these creatures serve as food for bird and fish. The hunt goes on continuously, the little boatman devours the lesser insect, the fish live on the flies and other water animals, some like the pike even devouring birds or frogs and rats. The fish themselves are attacked by otter and heron and kingfisher. Even snakes will occasionally invade the water, and though

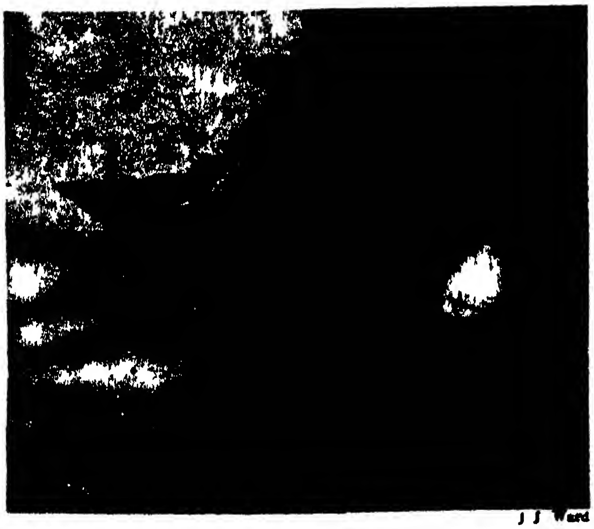


J.J. Ward

DIVING BEETLE AND ITS EGG COCOON

Under-water creatures as small as the diving beetle are sometimes rather hard to find and study, but here are some splendid photographs of the creature. It is a vegetarian and makes a cocoon (bottom) for its eggs. The cocoon has a special ventilation shaft which, as we see, projects through the surface into the air.

only the adder among British reptiles attacks birds the so-called harmless grass snakes live on frogs and other things But life is merry in the river The hunted are not afraid, though they are watchful and seldom does the victim know much of his own end much less feel pain The variety of life is beyond all reckoning Some, like the crayfish, live all the time within a square yard or so of the same spot Some like the otter which shares the love of most so called vermin for wandering will travel miles even from one brook to another All the water haunting birds and the vermin, including the grey rat, will take considerable journeys, but the little voles are very faithful to one short reach of their home stream, not moving very much farther than the water snails which swim quite long distances for such a creature lying on their backs the while like water boatmen and keeping themselves afloat solely by use of what is known as the surface tension of the water



J J Ward

M H Crawford

FRESH-WATER SNAIL AND DRAGON-FLY OF THE BROOK

The most common shell-bearing creature of the English streams is the fresh water snail of which there are a number of varieties In the left hand photographs we see its shell (bottom), and (top) the snail crawling up the side of a glass tank with its remarkable "foot" adhering to the glass The lower illustration on the right shows a dragon fly resting upon a water plant, and (top) the cast skin left when the insect forsook life beneath the surface for the freedom of the air A dragon-fly is one of the brook's most joyous sights

Aitken, Ltd

INDIAN ELEPHANTS IN THEIR ELEMENT: A BOISTEROUS BATHING PARTY

All elephants are fond of the water, but the Indian elephant is the best of them all as a swimmer It is at home in the deepest water, and is very fond of staying for hours in a river with the body entirely below the surface and just the head and trunk appearing This fondness for bathing is just as keen in the captive as in the wild animal, and a captive elephant, to be happy, must have a swimming pool in its cage While the African elephant seems to be more or less indifferent to extreme heat, the Indian species likes plenty of shade, and no doubt it is the desire for cool surroundings that has led to its habit of prolonged immersion and its strength and skill in swimming

Chapter XXIII

The Great Elephant & its Little Relation

By G. M. Vevers

Superintendent of the London Zoological Society's Gardens

It is curious that the greatest of all land animals, weighing several tons, and sometimes standing nearly twelve feet at the shoulder, should have as its nearest relative a little creature no bigger than a common rabbit; yet zoologists, after studying the anatomy of the elephant and comparing it with that of the rock rabbit, or coney of Africa, are agreed that this is most certainly the case.

In outward appearance it would be hard to find two animals so extremely dissimilar, for, in addition to the disparity in size, there is no single external feature which gives a clue to the relationship, and it is only by a careful comparison of the skeletal structure of the feet that kinship between these two creatures can be established. This kinship dates back to the Secondary Epoch in geological time, when the primitive stock of mammals seems to have started to divide up into the more or less distinct groups which we recognize to-day. In those days the elephant did not exist as we know it, nor had its then living ancestor developed anything worthy of the name of trunk. From fossil remains we suppose it to have been a rather clumsy animal, somewhat tapir-like in appearance and size, with only the barest suggestion of a proboscis. It is at this point that we get the first evidence of the relationship. This creature which is known to scientists as the Moeritherium was descended from the same line of ancestors as were the progenitors of the rock rabbit.

Next in the ancestry of the elephant came a beast called Palaeomastodon, which was the first of all the elephants to own the beginnings of a trunk. From the Palaeomastodon palaeontologists have traced a perfect succession of links in the chain of evolution of the elephant family down to the recently extinct mastodon mammoth and the elephants of to-day. In the earlier members of the group, the lower incisor teeth were almost as markedly developed as the upper incisors, which have become the tusks of the modern elephant, but after attaining an almost grotesque state of over-development in a creature known as Tetrabelodon, which flourished in Early Pliocene times, the lower incisors faded away, and in the more recent and existing forms of elephants have become non-existent. As the lower incisors gradually disappeared, the snout and upper incisors remained, developed in size and so became the trunk and tusks of the animal as we know it to-day.

From time to time during recent years, there have appeared in the daily press lurid accounts of four-tusked elephants of gigantic size which still lurk in the jungles of darkest Africa, but these stories come under the heading of "travellers' tales," for it is certain that, apart from malformed specimens, a few of which are known to exist, no four-tusker has ever walked the earth since the far days of Tetrabelodon.

While in the course of evolution the elephant has increased in bulk, the coney appears to have decreased in almost the same proportions, for it had as one of its ancestors Megalohyrax, which was a contemporary of and about the same size as the Moeritherium.

Both groups originated in Africa, but whereas the elephant (as fossil remains show) wandered over the greater part of the earth, secure in its massive strength, the coney family hardly strayed from home and no remains of it have been discovered further afield than Greece. Here perhaps is a case in which the psychology of the individual has been to some extent a factor in the trend of evolution. Different habits became evolved, and on the one hand we have a story of increasing size and strength, culminating in the Mastodon, while on the other we have an animal of furtive, cringing habit, ever decreasing in courage and size till it reached its present state.

The hairy Mammoth which is found preserved in the frozen wastes of Siberia is the most recently extinct member of the elephant family. It is very closely allied to the Indian elephant, the main difference being the shape of the tusks which have a spiral curve, and the long, brown, woolly coat, which served to keep this lumbering creature warm during the bitterly cold period which preceded the last Glacial Epoch. So well preserved are the remains of these frozen giants that sometimes their flesh is found to be quite edible if eaten directly after it has been thawed. It is not, however, for the flesh that these semi-fossilised creatures are unearthed, but for the ivory of their gigantic tusks, of which many thousands of tons have found their way into the market during the past fifty years.

The elephants of to-day may be broadly divided into two races, the African (*Loxodon africanus*) and the Indian (*Elephas maximus*), although in both Africa and Asia there are local races showing slight variations in form and in Africa there is a pigmy race which has recently been described as a separate species (*Loxodon pumilio*). In Burma and Siam the occurrence of so-called White Elephants is not an uncommon event. Some sixty authentic cases of these have been recorded in historic times. They are albino forms of the true elephant, and, as a rule, are of a dirty pink colour, with mottled pigment here and there on the body. The iris of the eye in most cases is white, and in the dark the retinal reflection is pink. A living male White Elephant from Burma was shown during the summer of 1926 at the Zoological Gardens in London; it was about eight years old and little more than half-grown. This specimen was remarkably free from pigment, and was probably the most perfect specimen of a "White Elephant" ever captured. Albino elephants are held to be sacred in Burma, and

Bonnaire

HOW HANNIBAL FERRIED THE "EARTH-SHAKING BEAST" ACROSS THE RHONE AGAINST THE ROMANS

At the time of the Second Punic War (218-201 B.C.) between Carthage and Rome, the elephant seems to have been common in Africa as far north as the Mediterranean hinterland, though now it has retired to the remote central regions of the continent. Thus the Carthaginians had an apparently formidable new "arm" to favour their warfare. In fact, these enterprising people used elephants in much the same way as the "tank" has been used in modern warfare. A howdah filled with armed men was strapped on the animal's back, but the main effect was undoubtedly a moral one. Hannibal, a military genius, invaded Italy by crossing the Pyrenees, the Rhone, and the Alps, but the hardship of the last barrier took great toll of his elephants

Zoological Society's Bulletin

ANCESTOR OF THE ELEPHANTS, THE MAMMOTH, DISINTERRED IN SIBERIA

Like the other mammals, the elephant, as we now know it in its different species, has descended through the ages from strangely different ancestors. The most recently extinct of these forbears is the mammoth. This creature, which was smaller than the average Indian or African elephant, was covered with long hair, just as infant elephants are now. Its remains are dug up in Siberia where the ground is frozen for some feet below the surface. In some cases the flesh of these carcases has been found fit to eat, even after such ages of cold storage.

in Siam if one is caught it is at once sent to the royal stables to have a king for master.

Besides the disparity in the size of the ear, which is the most noticeable point of difference between the African and Asiatic forms, the ear of the former being much larger than that of the latter, there are several other very obvious characteristics in which the two races differ. In general outline when viewed in profile the two species are totally dissimilar. The forehead of the Indian elephant is flat and raised into two large bosses and the highest point of the body is always in the centre of the back, whereas in the African animal the head is domed and slopes gradually into the back, which attains its highest point between the shoulders. The trunks of the two animals also show points of difference, that of the Indian elephant being smooth and tapering when compared with the trunk of the African, which is markedly corrugated throughout its length. At the extremity of the trunk in the African species the two finger-like processes which are used in grasping small objects are almost equal in size, whereas in the Indian, the anterior process only is present. The latter also has one more toe nail on the hind foot, the African only having three. The tusks of the African elephant attain a very much greater length and weight than those of the Indian. The longest known tusk is one in the American Museum of Natural History, and measures eleven feet five inches along the outside curve. It weighs 293 pounds. The longest tusk from an Indian elephant measures nearly two feet less, and its weight is not recorded. In the female of the African species, the tusks are usually well developed, but those of the female Indian elephant are small and sometimes scarcely protrude beyond the mouth. The molar teeth of the two races also differ in structure, the puckering of the enamel and the ridges or plates of the teeth being very much more numerous and compressed in the Indian than in the African race, in which the teeth show a more primitive design.

In size the Indian elephant is decidedly smaller than its African relative, the record Indian measuring ten feet six inches, while the tallest African, a giant from Zuga near Lake Albert, stood no less than eleven feet six and a half inches at the shoulder. It was a "one-tusker" shot by Major P. H. G. Powell-Cotton and is now in his private museum at Birchington. "Jumbo," the famous African elephant which lived at the Zoo during the middle of last century, and was subsequently sold to Barnum

DOCILITY OF THE GREATEST OF THE BEASTS WHEN KINDLY AND INTELLIGENTLY TRAINED

Wild, the elephant does not appear to behave with much of the sagacity with which elephants in general are credited. But in the hands of man and after long training, a mature elephant seems to develop a sense of reasoning and, besides, soon becomes docile and full of intelligence. The same elephant which raises one of its great legs for a child to touch can be trained to help in the capture of its own kind. The right-hand photograph shows an elephant of the Zoo at its daily task of carrying people about the grounds. It sweetens its labours with the aid of an inquiring trunk thrust in among the crowd from which various tit-bits are to be obtained, so experience has taught this great beast

Realistic Travels

TWO ROYAL ELEPHANTS FIGHTING IN THE PALACE GROUNDS

From time immemorial the elephant has been domesticated in India, and the rulers of the native states have always taken a pride in their royal stables. Our photograph shows two of the elephants belonging to the Gaekwar of Baroda set on to fight each other. Each animal is chained by one leg and a mahout or driver seated on the neck of the beast controls the proceedings. Elephant prices are much the same as motor-car prices, varying from £100 to £1,000, but animals under twenty years old are not valuable.

and Bailey's Travelling Menagerie in America, measured ten feet seven inches at the shoulder, and weighed over six tons. The mammoth was a smaller beast than either of the above, seldom exceeding nine feet in height, but there once existed in India an elephant, the fossil remains of which show it to have exceeded sixteen feet at the shoulder. This animal which is known as the Narbada elephant, was probably the largest proboscidean which has ever existed in the world.

In Malta, Cyprus, and other islands of the Mediterranean, remains have been found of several species of Pigmy elephants, none of which could have been much larger than a St. Bernard dog. Like the present Pigmy species, these appear to have been closely related to the African elephant as we know it to-day, and no doubt their small size can be attributed to their insular habitations. The existing Pigmy African species differs from its larger relative in having a very much smaller ear in comparison with the rest of its body. The extremity of the trunk also resembles the Indian rather than the African species in having the anterior finger-like process larger than the posterior. It probably never exceeds six feet in height. It inhabits the hinterland of the Congo, and is very rarely seen. Up to the present only three live specimens of this strange stunted type have been brought into Britain.

In habits the two races differ to quite a large extent. The Indian elephant is essentially a jungle-dwelling animal and is exceptionally intolerant to the rays of the sun, whereas its African cousin spends a great deal of time in more or less open country, and is apparently unaffected by extremes of heat. Similarly, in nature, the food of the two races differs considerably, that of the African elephant being composed of coarser materials than that of the Indian species; the former feeds chiefly on branches of trees, bark and saplings, whereas the latter prefers more succulent substances such as bamboos, plantains, and figs. This marked difference in diet corresponds to the difference in the structure of the molar teeth which has already been alluded to. In drinking, the water is sucked up into the trunk, which is then turned into the open mouth and emptied. Rice and other grains are treated in the same way, being blown into the mouth. Although it is generally supposed that the young suckle by means of the trunk, they actually suckle directly by the mouth.

YOUTHFUL BEHAVIOUR UNDER THE STIMULUS OF THIRST AND ANGER

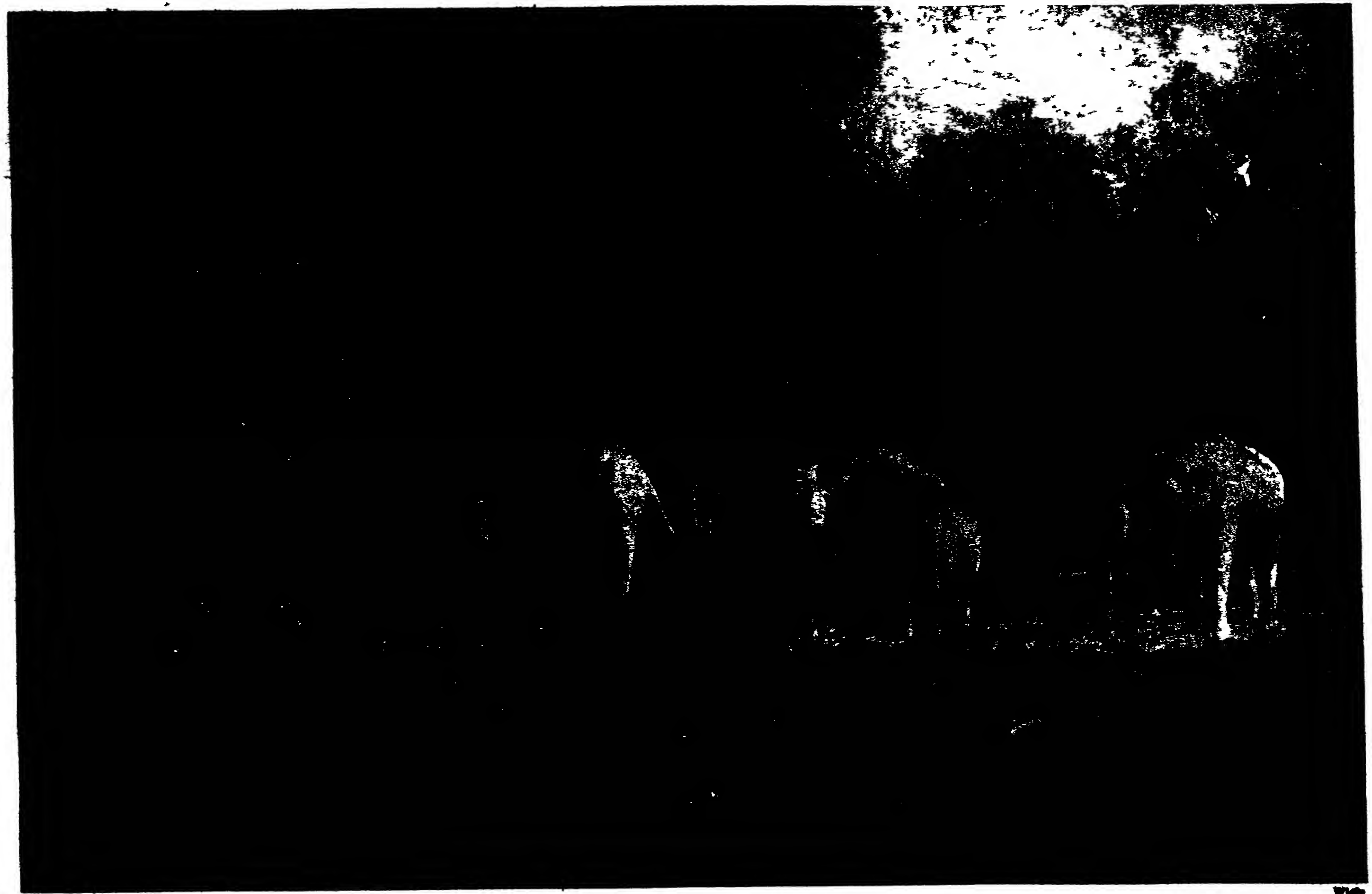
When the animal drinks it sucks water up its trunk and then squirts the trunk-full into its mouth In the lower photograph we see the use of this strangely-prolonged nose, for without it this elephant could not, even when kneeling, have obtained a drink from this pond Above is a young elephant at the Berlin Zoological Gardens which are particularly fine. It was irritated by a dog—small dogs seem especially to frighten and annoy elephants—and stuck out its tail and trunk in indignation at not being able to reach the nuisance.

F W Bond

Chandos Studio

LORD OF THE JUNGLE DOES MENIAL SERVICE FOR ITS MASTERS

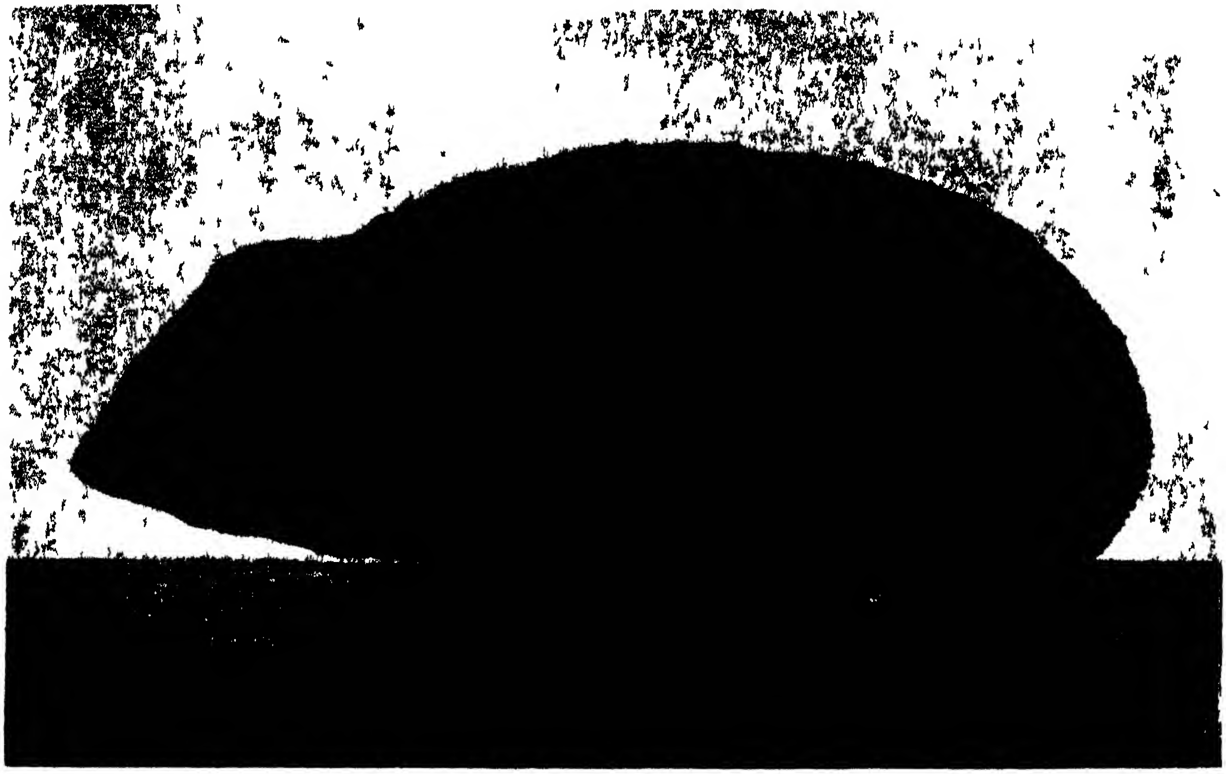
It is in the teak yards that the intelligence and strength of the elephant, developed and directed by man, are seen at their highest pitch. The animals are trained not only to carry the great balks of timber, but to arrange them carefully in stacks. The lower photograph shows an elephant at work drawing a teak log in the Southern Shan States of Burma. Above we see how the beast moves logs without the aid of harness—a unique performance among draught animals. The tusks play an important part in lifting



Wide

HERD OF ASIATIC ELEPHANTS IN THE FASTNESS OF A SIAMESE FOREST

What are called Indian elephants are by no means confined to India, but are found in Burma and in Siam. While there are some local individualities, the Asiatic elephants are all of a distinct type as opposed to the African. The most striking points of difference between the types belonging to the two continents are the size of the ears, which in the Asiatic elephant are comparatively small; and in the shape. The Asiatic elephant has a flat forehead raised into two large bosses and the centre of the back is always the highest point of the body. This marvellous photograph shows how a herd looks in the natural surroundings of a forest in Siam. The animals are sheltering from the heat and hot sunshine is suggested by the contrasts of light and shade.



LITTLE CREATURE THAT IS THE ELEPHANT'S NEAREST RELATIVE

This little animal, no larger than a rabbit, is nevertheless descended from the same remote ancestors as the mighty elephant and provides us with an example of the extremes to which evolution can lead Its name is the hyrax and there are some twenty species including the Cape hyrax, the tree hyrax which makes a very entertaining pet, and the Syrian hyrax which is mentioned in the Old Testament as the "coney" This last is the only member of the family found outside the continent of Africa

The period of gestation varies from eighteen to twenty-two months, and the young, which are born singly, are covered with woolly hair resembling the coat of the Mammoth

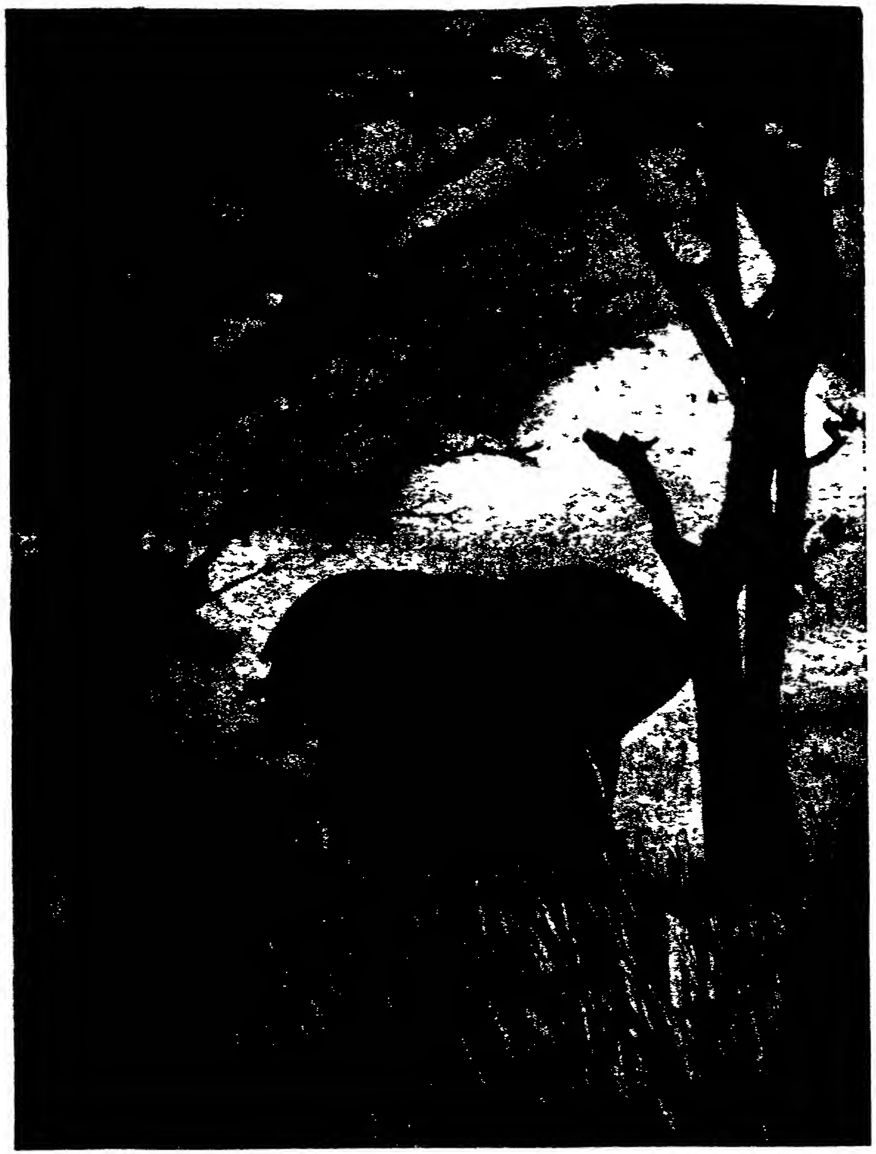
Both species are fast movers over a short distance, and a speed of fifteen miles per hour is not uncommonly kept up for a quarter of a mile or so, but whereas the African can keep up a speed of ten miles an hour for several hours on end, the Indian, being shorter on the leg and more cumbersome, cannot maintain a speed of more than six or seven miles an hour. Generally speaking, the African elephant is the more active and powerful animal of the two and is the more ferocious and ready to charge when attacked or disturbed The African charges with the trunk raised above the head, while the Indian coils up its trunk tightly and tramples its victims to death with the forefeet. Of the senses, that of scent is most highly developed in the African species, neither sight nor hearing being very acute in either race. Although both are fond of bathing, the Indian excels as a swimmer, and is quite at home in the deepest water, sometimes swimming for hours at a time with the body entirely submerged, and only the head and trunk appearing above the surface.

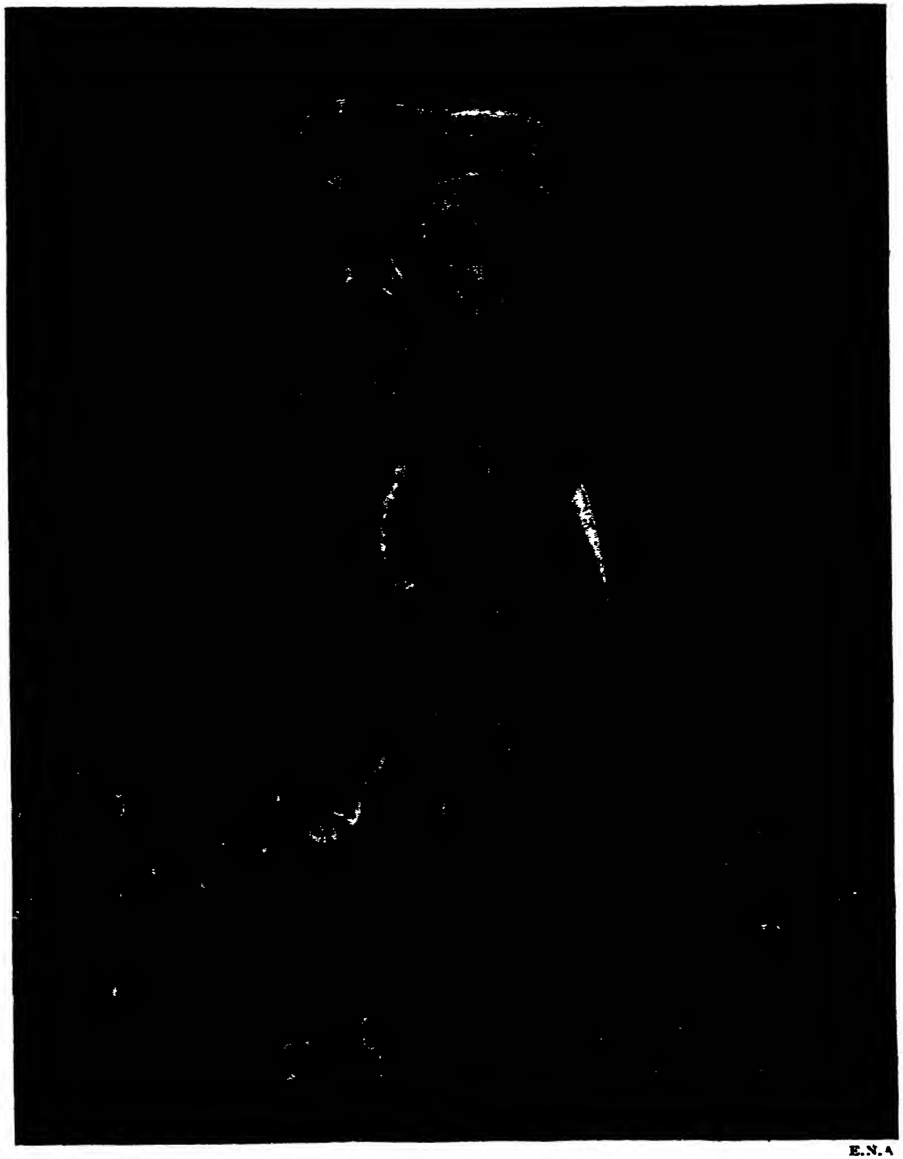
Mighty mountains of muscle and bone as they are, elephants are peculiarly lacking in powers of resistance to shock and disease. Many have been known to lie down and die of a broken heart when given too great a burden to carry, and they succumb to anthrax in a very few hours after the bacillus of that dread disease has found an entry into the bloodstream, in Burma alone this disease accounts for the death of several thousands of these animals every year Indeed elephants seem to be particularly susceptible to anthrax

From very ancient Assyrian and Egyptian records it is certain that in early historic times the Indian elephant had a much wider range than it has to-day, reaching as far westwards as Mesopotamia Similarly in the days of the Carthaginians, the African race extended to the shores of the Mediterranean, whereas now it is limited almost entirely to the central or equatorial belt of Africa.

IN India, Burma and Siam, elephants have been domesticated from time immemorial, being used for hunting, hauling timber, and as beasts of burden generally. It follows, therefore, that in these countries good working elephants can command a high price, and £800 to £1,000 is not infrequently given for a fully-grown, well-trained "tusker." Working females are not worth so much, and immature animals under twenty years of age may be bought for about £100

The young are not often born in captivity, and when a new "worker" is wanted it is usual to catch a fully-grown one out of a wild herd and put him through a course of training In the wild state the





E.N.A

WILD AFRICAN ELEPHANTS AS THE CAMERA DISCOVERED THEM BY DAY AND BY NIGHT

Steady hands and nerves are needed in the taking of such a photograph as this one of an old cow elephant (left) preparing to charge the photographer. Notice the enormous ears, outspread in anger, which are one of the characteristics of the African as distinct from the Asiatic elephant. Despite its bulk a charging elephant leaves one little leisure for avoiding it, and it can maintain a running speed of about fifteen miles an hour for four or five hundred yards. The African elephant slackens to about ten miles an hour for greater distances, but can keep up this average for several hours, whereas the Asiatic can only last a distance at little more than half this speed. The right-hand photograph shows a bull elephant of Tanganyika, and was taken at night.

Underwood

Photopress

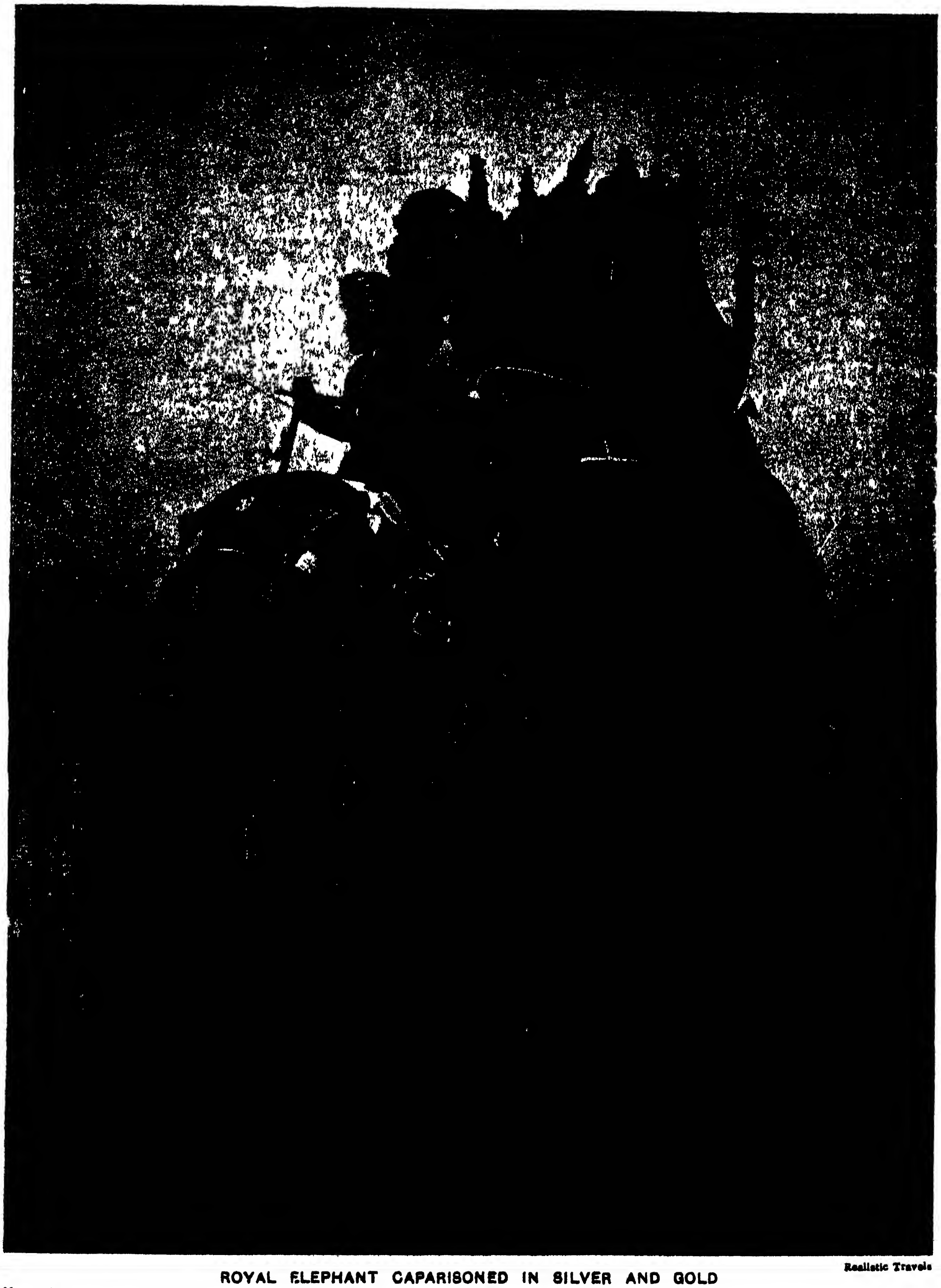
WHAT MAN CAN DO WITH THE GREATEST BEAST THAT WALKS THE EARTH

By many ingenious methods man has learned to capture and tame the elephant in Asia. In Africa there has never been the training of elephants on anything like the same scale, although it is now being shown that the latter species is far from being as intractable as used to be generally supposed. Our left hand photograph shows a man riding an elephant near Kandy, in Ceylon, while on the right an attendant is seen washing his enormous charge as it lies, cool and happy, in a river. Those in charge of elephants become very attached to them and the animals which have very good memories, are well able to repay kindness just as they very seldom forget to return evil for evil.

E.N.A.

ELEPHANTS OF SIAM AND KENYA IN THEIR WILD HOMES

Like cattle, elephants have a great fondness for standing close together, and when a traveller through the jungle comes upon such a group the sight is an impressive one. In the lower view we have a glimpse of the wilds of Siam with a part of a herd cooling itself in the water. A very different scene is depicted in the upper photograph where we are shown the wild uplands of Kenya and a solitary elephant proceeding on his lordly way. The African elephant used to exist in vast herds, but the ivory hunters have reduced the numbers sadly.



Realistic Travels

ROYAL ELEPHANT CAPARISONED IN SILVER AND GOLD

Upon their elephants the native princes of India have always lavished all the wealth of Oriental ornament. This is the state elephant of the Maharaja of Patiala as it appears when the prince has to attend at some state occasion. Not only has it magnificent trappings—a howdah of gold and silver, rich embroidery and splendid trinkets—but its trunk and its great ears are brightly painted, too, when this leviathan of the land goes forth among its master's people upon occasions of pomp and princely circumstance.

Indian elephant is by no means an intelligent creature, but under the influence of man he becomes docile and obedient, and to some extent is able to develop the power of reasoning.

It is a popular supposition that the African elephant is not so docile or intelligent as its Indian relation, but this idea has arisen probably because in Africa from early historic times until quite recently no attempt was made to capture and train elephants on the same scale as it is done in India There is, however, substantial evidence to show that the African elephant was used in battle and as a beast of burden by the Ptolemies in Egypt and by Hannibal in the Punic Wars: in fact, many ancient coins and medals have been found upon which are stamped elephants of undoubted African origin with riders on the head.

MORE recent evidence of the tractability of the African species may be found in the records of the Zoological Society of London, and of the elephant training school at Api, in the Belgian Congo, where systematic training of elephants has been going on for the past 25 years. The famous African elephant, "Jumbo," who came to this country when quite a youngster in 1865 and grew to maturity in the Zoo, until he was sold to America 17 years later at the age of 26, was in the habit of carrying scores of children for rides on his back every fine day during the summer months, and another African elephant, a female whose name has been forgotten, gave proof of her docility in the same way.

At Api, in the Congo, there were in 1928 fifty elephants in training, 19 of which had completed the course and were working animals The training is done by local natives who learnt their business from seven Indian mahouts imported in 1920 as instructors. Half-grown wild elephants are chosen for training, which is carried on for ten years before the animal is strong enough for regular work. Attempts to shorten the period of training in the past have always ended in the death of the animal. At present the costs of running the school at Api are being met by the King of the Belgians out of his private purse

FROM the days of the great Persian King Cyrus down to comparatively recent times, the elephant has been an important factor in warfare. The Romans met elephants in battle in 280 B.C., when they were used by Pyrrhus of Epirus, but they did not become really familiar with their use until the Second Punic War, when Hannibal invaded Italy from the north, bringing his troops and elephants over the Alps by way of the St. Gothard Pass. It is related by the Greek historian, Polybius, that many hundreds of these animals perished while crossing the mountains, and by the time the army had reached the Arno, in Central Italy, the only elephant to survive was the one that Hannibal himself rode.

It was left to Scipio Africanus to discover how to counter these new "engines of war," and at the Battle of Zama he ordered his archers to shoot their arrows at the trunk which is the most sensitive part of the animal. The result was that the elephants became panic-stricken with pain and turning round, charged through the ranks of their own unfortunate infantry and trampled them to death.

The age to which elephants may live, in common with that of many other large animals, has always been a subject of much speculation. It was formerly thought that they could live for many centuries. In India the natives believe they live to any age up to 150 years; on the other hand Government statistics show that the life of a working elephant in captivity is seldom more than twenty years after purchase. Twenty-five years' duration in a menagerie or zoological collection is considered good. Metchnikoff, an accepted authority on longevity, states that the elephant, in proportion to its size, has not a high potential longevity, and that one hundred years is the probable age limit and thirty years a good average.

TO return to the poor little relative of these colossal creatures which have played and are still playing an important part in the history of the world, would seem in some ways to pass from the sublime to the ridiculous, and yet the little coney or "dassie," as it is called in South Africa, is interesting in that by comparison with the elephant it provides an example of the extremes to which evolution may go. In external appearance, form and colour, the coney is not unlike a common rabbit with a somewhat rat-like head. There is no tail, but a small tubercle takes the place of this appendage and it does not hop like a rabbit but walks or runs, using its legs separately. The forelegs are shorter than the hindlegs, giving the animal the appearance of being low in front. This is accentuated by a bushy collar of hair round the throat. It has four toes on the front feet and three behind, each supplied with hoof-like nails except the inner toes on the hind feet, which are long and are used as "toilet digits."

The coney has no canine teeth, but it has two incisors in the top jaw and four in the lower, which resemble those of a rodent. The molar teeth, of which there are eight in the upper jaw and seven in the lower, resemble those of a rhinoceros in both form and number.

These little animals generally live in the hollows and caves of rocks on the hillsides and down on the seashore just above high-water mark. They are extremely timid and shy in the wild state, although in captivity they become tame, and some species even become aggressive to strangers. They are entirely vegetable feeders, and their flesh tastes like rabbit. Being exceedingly agile and quick in their movements, they are very rarely caught alive, but there is one species, the Tree Hyrax from Nigeria, which makes an ideal house-pet and is much sought after by animal dealers.

In all, about twenty species have been described, the commonest being the Cape Rock Rabbit (*Procavia capensis*). The only species found outside Africa is the Syrian Hyrax (*Procavia syriacus*), or coney of the Bible, which the writer of Proverbs describes as being a feeble creature having its dwelling among the rocks.

Chapter XXIV

The Mystery of The Puma

By Hamilton Fyfe

How or when the fear of man, which is instinctive in almost all wild animals, became an instinct we do not know. We do know that no other living creature is so generally mistrusted. Occasionally we hear of animals which have never before been in the presence of human beings showing curiosity rather than alarm at sight of them. It is very rare indeed to find a wild animal which seems to regard man as a friend, not an enemy. That is the chief of several reasons why the puma is so interesting and attractive a beast.

The largest after the jaguar of the American cat tribes, it is found—or, rather, it was found until populations grew thick—in all parts of the two Americas. In Brazil it was called cougar, and that name is used quite as much as puma, which is Peruvian. In North America it was known also as "painter," a contraction from panther.

It is not very large, from six to nine feet long, including some three feet of tail. Its colour is tawny on back and sides, whitish underneath, with a dark line along the backbone and a brown tip to the tail. Its ears are black, its upper lip white, its nostrils flesh-coloured instead of black. Once pumas were spotted; this is made clear by the cubs, which carry spots for six months, then lose them, as their ancestors lost them long ago.

The food which the puma prefers to any other is horse-flesh, but since the wild horse of the pampas has been almost exterminated by him he has to be content with sheep or cattle (he would rather have sheep), with deer, grouse, rabbits, or even rats and mice.

In the valley of the Orinoco and in that of the Amazon, pumas prey on monkeys, pursuing them in the trees with astonishing agility. They can leap from the ground on to boughs twenty feet above them; and they are just as fine performers at long jumping for on the flat their jumps sometimes measure nearly forty feet.

In the Adirondack Mountains, U.S.A., they have been known to eat porcupines and snails. Here they would devour part of a kill and leave it to be finished another day. This they could do safely in a cold climate, but in the Argentine they seem to know that meat goes bad very quickly, so they never return after they have had their first meal off an animal killed.

Their method of attack is ingenious. They leap on a horse's back. One paw grasps its chest; the other paw seizes the head and, with a quick wrench, dislocates the neck.

North American observers describe the puma as a coward, yet they say that when he is wounded he rushes fiercely on his assailants, and they tell how any dog that ventures too near "receives such an energetic cuff from the puma's paw that he rarely solicits another." Those who have studied the species in South America deny that it can be called cowardly, but draw a sharp distinction between its behaviour to other animals and to men. That it will not attack or even in some circumstances defend itself from the human race, they admit; but this is not cowardice, they say. It is due to some unexplained influence which the human race seems to have upon it.

This influence is strong enough to make the puma, which will fly at the jaguar—a much larger beast than itself—run from man, and even sit unresisting and trembling while man deals it a death-blow.

Nor is that the most surprising manifestation of the instinct which has caused the natives of South America to call the puma *amigo del*

PUMA ON THE WATCH

After the jaguar this is the largest of the cat family in the New World, and it is found both in North and South America. In the former it is called painter or panther, and in Brazil the cougar. It is a handsome, fine-looking creature, as this photograph shows.

Neville Kingston

THE PUMA YAWNS

The photographer has taken the opportunity of a yawn to show us the magnificent array of teeth with which the puma is equipped. But the animal uses its powerful paws rather than its teeth for defence and for killing its prey

cristiano, the friend of the Christian. It has actually been known to volunteer its services as a protector of man. W. H. Hudson heard and believed this story. A hunter of ostriches on the pampas fell from his horse, breaking his leg. He lay all night in the open, defended from a jaguar by a puma, which kept the fiercer creature off and saved the hunter's life.

Humboldt called the affections and antipathies of animals mysterious. Many naturalists say they are not more mysterious, however, than those of men and women. Yet no one who has studied the puma has ventured to suggest any explanation of its attitude towards human beings. That remains a mystery, and one of the most puzzling in nature.

It is too much to say, as W. H. Hudson said in his Naturalist in La Plata, that the puma "never makes an unprovoked attack on a human being." There is evidence to prove that on the North American continent unprovoked attacks have been made. For example, in the state of Washington, U.S.A., some schoolboys saw, as they went home from school, what they took to be a yellow dog in some bushes. They did not molest it. Suddenly it sprang on them, seized a little fellow of six, and ran off into the bushes with him. An elder boy, not more than twelve, bravely followed. With an empty bottle he hammered the animal's head to such good effect that it released the small boy and bolted.

It has been surmised that the puma was in a playful mood, and did not mean to hurt or devour the child. Pumas are often described as being like kittens in their behaviour. When they are caught young and brought up as pets, they never tire of games. In captivity they are cheerful and affectionate, seldom giving any cause for alarm. Edmund Kean, the English actor, kept one as a pet; it used to follow him about. He was accustomed to exhibit it to friends in his drawing-room. There seems, indeed, to be some instinctive tie between human beings and pumas, as there is between us and cats.

In a record of travel in Central America (J. W. B. Whetham, 1877) the story is told of a mahogany cutter walking through a forest and feeling something soft press against his legs. "On looking down he saw a cougar, which, with tail erect and purring like a cat, twisted itself in and out of his legs and glided round him, turning up its fierce eyes as if with laughter." Unfortunately, the man was so terrified that he struck at the creature with his axe and it made off.

Possibly the puma which seized the little American boy had friendly intentions. That could hardly be the explanation, however, of the attack made by a puma on a Swedish settler in British Columbia. This man was clearing a site for his house when the animal leapt on him and fixed its teeth in his arm. With a yell of pain, he kicked it in the stomach and it let go. Then ensued one of the most enthralling fights between man and beast that have ever had the fortune to be recorded.

The puma began the second round by springing at the Swede's throat. He guarded with his left and landed his right heavily on its ribs. It went back to its corner, breathing hard.

Third round. The puma sprang again and seized the man's left hand. With his right he pommelled and with his feet he kicked. It was at last forced to release its hold.

Fourth round. The puma sprang this time on to the Swede's breast, knocking him against a tree. He recovered himself and kicked it once more, inflicting severe punishment.

Fifth round. As the puma came at him, the Swede saw his spade on the ground. He managed to pick it up and successfully kept his antagonist at bay.

Sixth round. The puma leaped and got a hold on the man's leg, but now he was armed. He raised the spade and drove it through the animal's skull.

Both these instances of unprovoked attack on human beings happened in North America. Hudson drew his information entirely from South America. There is some difference between the pumas of the two continents and it may be that in the southern, or at any rate in the portion of it in and about the Argentine, they are as uniformly well-disposed towards man as Hudson imagined.

Mystery of the Puma

The puma of North America is certainly not so ill disposed to dogs as his relation in the centre and the south. He does not like them, but their mere presence does not provoke him to fury. Even when the South American puma is tamed, this fierce antipathy persists. One that had been for years in a menagerie was being taken about among visitors on a lead. Suddenly they saw it stop, fix an intent gaze on something, bristle up its hair and roll its eyes. Then it broke away from its keeper and bounded in among the crowd. They scattered in terror, but the animal took no notice of them. It had spied a dog; that was the whole cause of its excitement.

The South American puma will even disregard blows from a man when its attention is taken up by dogs. A Scottish sheep farmer in Patagonia told Hudson how he and some of his dogs came upon a puma. The dogs were afraid to attack it. The man struck at it with a stick. It dodged his blows, keeping its eyes on the dogs all the time. He lost his temper, hit out wildly, broke his stick on the ground. He was now defenceless and expected the puma to spring and tear, but it ran past him and rushed after the dogs. His partner came up then and shot it.

Europeans do not hesitate to kill pumas, but there is a strong feeling against it among South Americans. This goes back a very long way. In a History of Lower California it is related that the missionaries who went to that country towards 1700 found it overrun by pumas. It was impossible to keep cattle or poultry. The deer were almost exterminated. The Indians could only eat flesh when they saw vultures hovering over a puma's kill; they hurried to the spot and feasted on the remains. They would not for anything kill a puma. They were convinced that if they did they would themselves be struck dead.

The missionaries strove vainly against this superstition until there was sent out a man of stiff character and great bodily strength. He determined to show the Indians that there was no need to be afraid of the consequences of killing a puma. He went into the woods and brought one down with a large stone.

Neville Kingston

ONLY WILD ANIMAL THAT IS FRIENDLY TO MAN

The puma seems to be an engaging beast in many ways. It has long been known in South America as " the Christian's friend," although there have been plenty of Christians who have cursed its cattle and sheep-killing habits. But when confronted by man it usually seems to behave like a large and friendly cat. A wild puma will purr in the presence of man and even rub itself against his legs. But apart from this it has the pleasing habit of playing for hours by itself in the midst of the desert at hide-and-seek or at chasing butterflies.

Then he slung it across his mule and took it to show the Indians. They were very much alarmed; they looked to see him drop dead at any moment. But he remained alive and well and after this the puma was treated like any other wild animal. One cannot help wishing that the missionary had been inspired by the example of Saint Francis of Assisi and that the friendship between beast and man could somehow have been kept up

THAT there must be foundation for the story seems certain from the reluctance to kill pumas which is still to be noticed in parts of South America. Even those who are not natives of the country are affected by it. Thus a gaucho, or cowboy, who was English by birth told Hudson that he had only once killed a puma and was filled with remorse whenever he thought about it.

"It sat with its back against a stone and did not move even when the noose of the lasso was thrown over it. When I went forward with my knife unsheathed, it made no attempt to get away. It seemed to know what was coming. It began to tremble, tears ran from its eyes, it whined in the most pitiful way. After I had killed it, I felt that I had committed a murder."

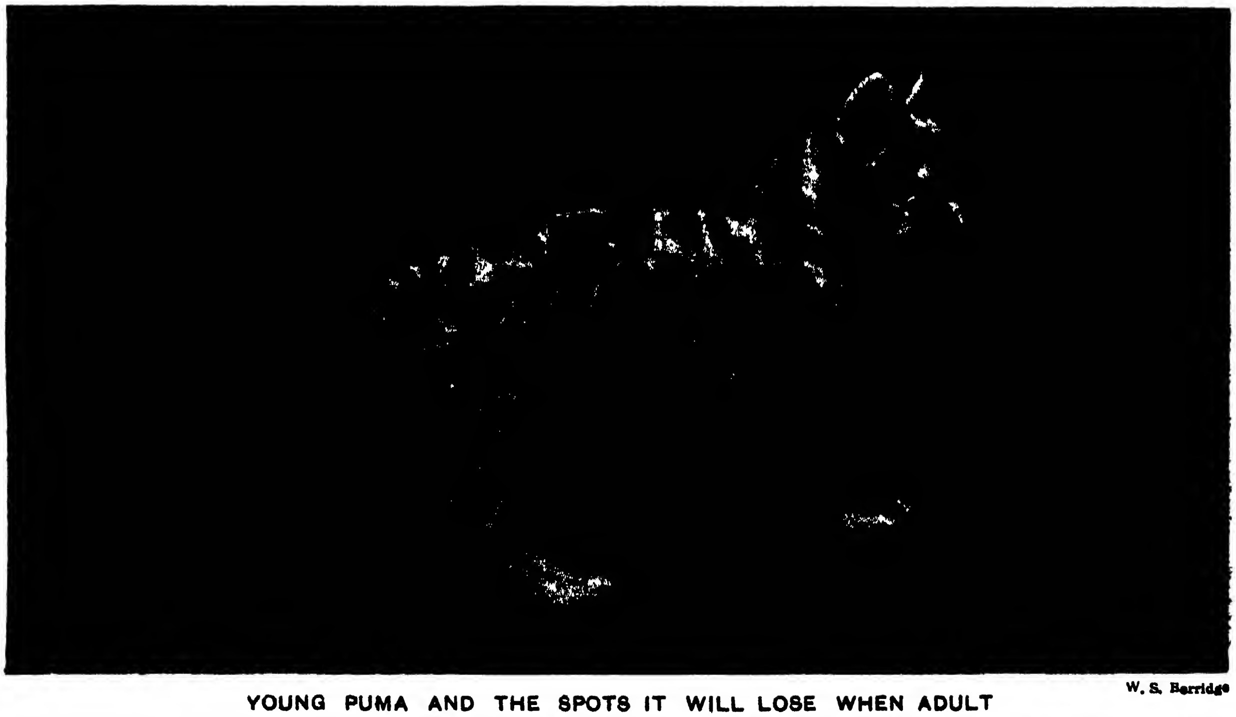
That this puma was not exceptional in its manner of meeting death at human hands is proved by the statement in the Natural History of Chile, by Claudio Gay, that "when attacked by man its energy and daring at once forsake it, and it becomes a weak, inoffensive animal, and, trembling and uttering piteous moans, it seems to implore compassion from a generous enemy."

The screams of the puma which old writers described as piercing and terrible existed, it is fairly certain, in their imagination only, or in the imaginations of those from whom they got their "facts." Darwin said pumas rarely yelled; the rare occasions were in the breeding season.

Unhappily, civilised man has seldom been a "generous enemy" to the puma. If fear did not urge its slaughter, if the desire to show skill did not impel hunters to lasso or shoot it, mere unreasoning hostility to all wild creatures or even spite has often been the motive for its destruction. Hudson heard a story in the Argentine which illustrated this and proved that pumas did sometimes hit back.

A cowboy who had failed rather ignominiously to justify his reputation as a jaguar-slayer was riding home angrily when he saw a puma come out of the long grass a little way ahead of him and sit down in his path. Here was a chance to wreak his fury and revenge, to release the savage rage that burdened his heart. He dropped from his horse, tied its forefeet together in a hobble, then drew his long knife and rushed at the puma. It did not run away. It waited for him to strike, then dodged the blow with lightning quickness, and lifting a paw tore the flesh from one side of the cowboy's face. Then, after looking at him for a little, it scampered away.

The man recovered, but was disfigured for life. But he could never forget his appalling punishment for the harm he had intended to an inoffensive beast.



W. S. Berridge

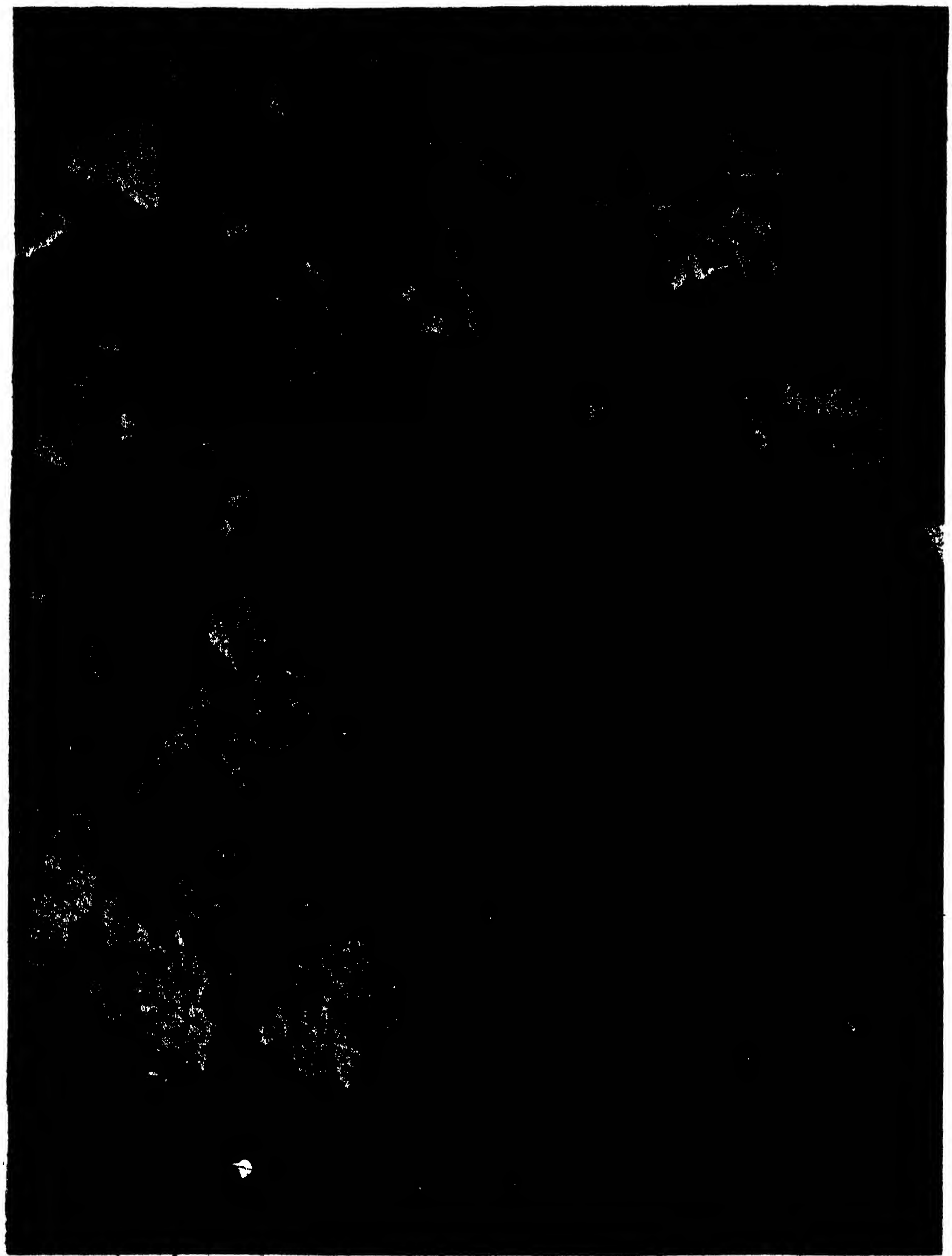
YOUNG PUMA AND THE SPOTS IT WILL LOSE WHEN ADULT

During its youth the puma is covered with black spots, but when it comes to riper years these markings disappear and the fur on its back becomes a very handsome cinnamon colour, while the chest is white. The tail, also, is very handsome, being long and beautifully rounded. And so, not only will this become a pleasant-mannered, but also a very handsome creature. In the meantime, it is as pretty to look at and as amusing to watch as any kitten and it keeps its playful habits all its life

W. S. Berridge

HOW MOTHER PUMA LIFTS AND CARRIES HER YOUNG

In the lower photograph we see a puma cub, three weeks old, being carried by its mother, while the upper photograph shows how the cub is picked up. No kitten ever played more wholeheartedly or more amusingly than a puma cub. But later on it can take life seriously, as various animals know. In forest regions of Brazil it takes to the trees and hunts monkeys with extraordinary agility, and it can leap twenty feet from the ground to a branch, a truly wonderful performance for any animal.



H. Bastin

SWARM THAT HAS NEWLY DESERTED ITS OLD HOME TO FOUND A NEW ONE

From early spring onwards, queen and workers are busy producing a populous and thriving colony. The drones are hatched, and the hive is full to overflowing with from 30,000 to 90 000 inhabitants. It is apparently decided in some way that the surplus population must emigrate. The queen of proved fruitfulness will go with the adventurers, leaving a number of developing queens in the cells. Suddenly, as at a prearranged signal, half the inhabitants rush out of the hive and gather in a cluster, hanging by their hooked feet about their queen.

Chapter XXV

The Wonderful Commonwealth of the Bee

By Rev. Tickner Edwardes

Author of "The Lore of the Honey Bee"

THERE have been more fictions, born in past ages and still popularly accredited, about the life of the honey bee than of any other living creature in the world. And yet, now that the mysteries of hive life have been, and are still being, honestly and painstakingly explored by competent observers, the truth stands out as far more wonderful than any of the extravagant fancies put forth by the self-styled savants in bee-craft extending over literally thousands of years.

It was always known—the most rudimentary intelligence could scarcely overlook the fact—that the life of a bee-hive was carried on under some sort of intelligently directed government. Any one could see that the busy throng of bees incessantly leaving and returning to the hive throughout a summer's day were actuated by a common motive. It was also obvious that a system of division of labour was in force among them. Some bees, the greater part apparently, went to the fields to suck the sweet juices from the flowers, and to gather pollen, bringing both home for the use of the hive, the pollen being carried very conspicuously in little highly coloured lumps attached to the thighs. Other bees would leave the flowers alone, passing straight over the most alluring pastures to the little stream or pool beyond, where they would eagerly fill up with water and return at once with it to the bee city.

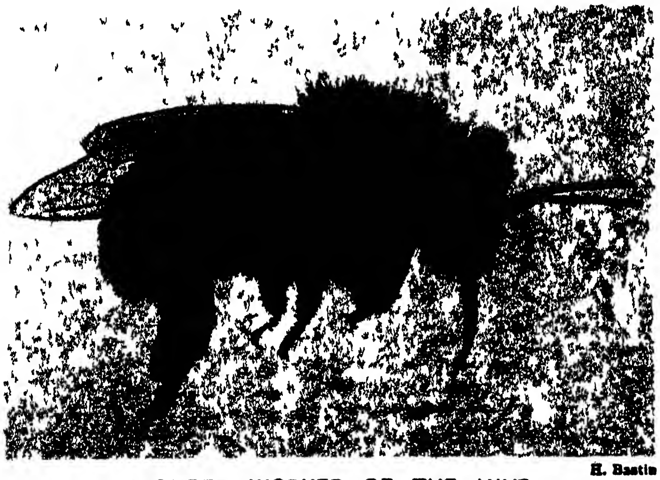
But a large number of bees seemed not to leave the hive at all, even in the brightest hours of summer sunshine. These busied themselves with the internal work of the hive, crowding together between the combs, or ranging themselves in open rows just outside the entrance to the hive, with their heads towards it, rapidly vibrating their wings. Others were evidently performing the duties of guards or sentinels to the stronghold. These bees congregated about the entrance carefully scrutinising all incomers, and occasion ally pouncing upon some intruding stranger and stoutly driving her away.

Then it was seen that the bees inhabiting the hive were of two different sizes—small bees who did all the fetching and carrying, and were about early and late, and larger bees who emerged from the hive only towards noon of the day, and seemed to do nothing but fly about with a great noise and get in the way of the busy ones. The limit of exact knowledge was reached when the presence in the hive of a single large bee was recognized; and this bee, never observed abroad in the ordinary way, was of course imagined to be the ruler or king of the whole colony, the rest of the hive inhabitants being his subjects, male or female according to their size.

To these meagre facts were added from time to time throughout the ages numberless inventions by the so-called bee-masters, who, seeing that the ancient hives were absolutely sealed books to the keenest human eye, and thus nothing could either be proved or disproved, had no compunction in letting their fancy run riot for the entertainment of the credulous. The modern bee-hive, however, with its combs built within movable frames rendering every corner of the hive readily explorable, has swept away this cloud of false witnesses, yet in doing so has only served to render the wonderful communal life of the honey bee more wonderful still.

The first truth which one must grasp in any attempt to gain an accurate view of hive life, is that it contains no sort of central directing principle resembling a monarchy, absolute or otherwise. It is pure Socialism, and that brought to what seems the finest point of perfection. The single large bee which the ancients observed to exist in every normal hive is, as every child knows to-day, no king but simply the mother bee of the colony, the single fertile female bee who is the parent of all the other inhabitants of the hive. We call her the Queen Bee That is a pretty idea, but nothing more. In fact, it is a complete misnomer. The mother bee takes no part in the direction of hive affairs, nor has she either capacity or equipment for the task. She exists in the hive for one purpose only—the production of eggs.

To the worker bees alone belong not only the entire government of the commonwealth, but the duty of carrying out the various works and initiating

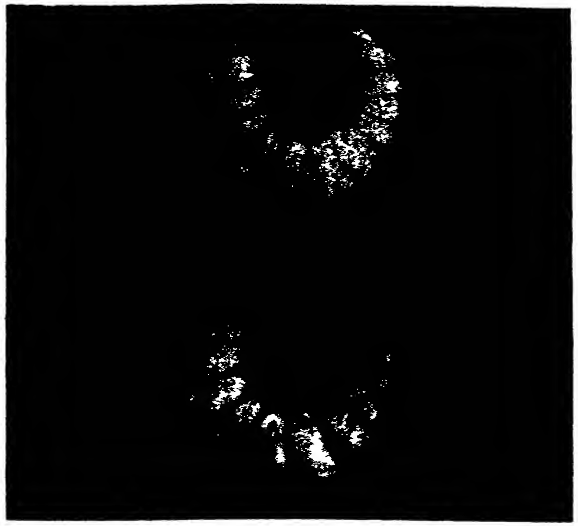


H. Bastin

WONDER WORKER OF THE HIVE

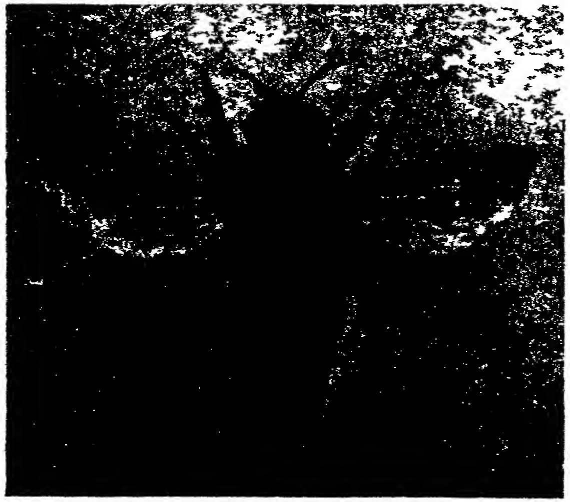
Efficiency, and efficiency only, seems to be the characteristic of the bee The photograph shows a "worker," and no machine was ever made to equal it in versatility; while, as a living creature, it has even eliminated sex so that nothing shall interrupt the work for which it is born

Pupa, upper and under sides

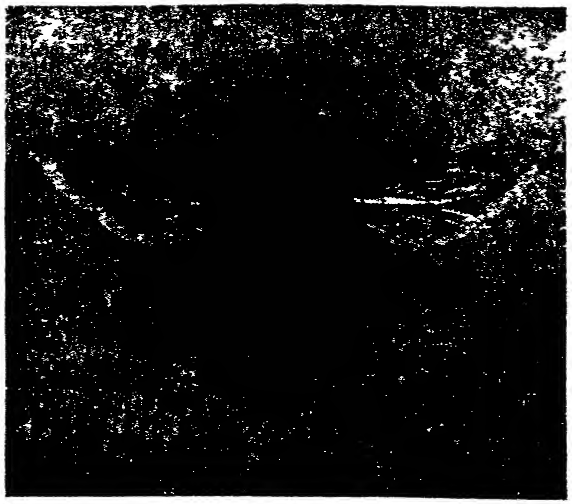


Early larval stages

Larva changing to pupa



Queen

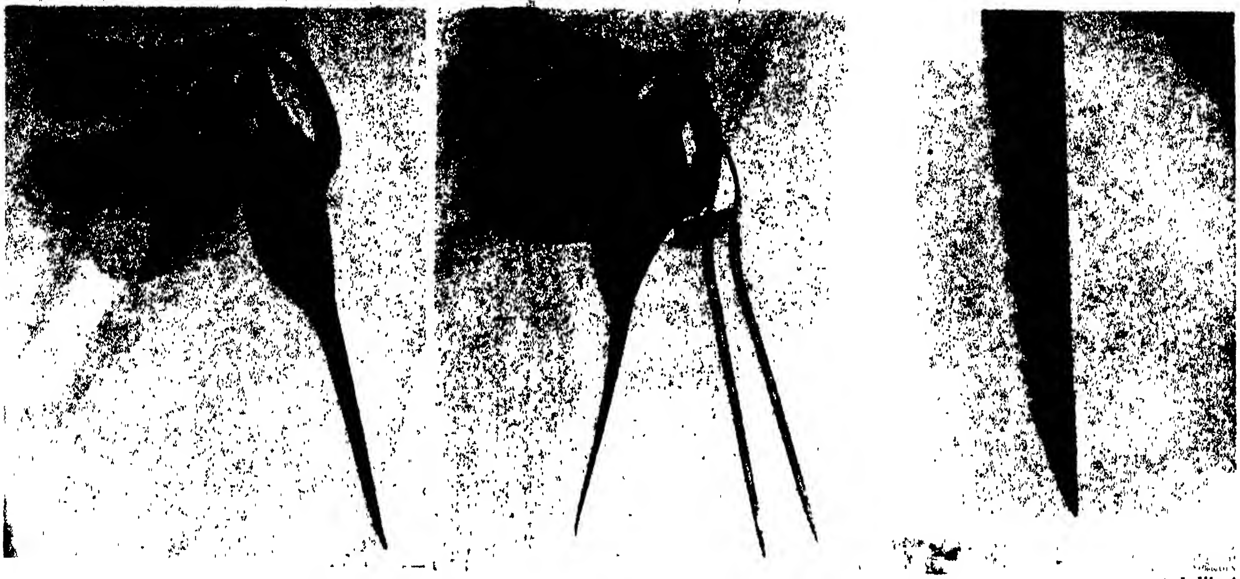


Worker

Drone

QUEEN, WORKER, AND DRONE BEES, AND THEIR STAGES OF LIFE

With the laying of an egg in a cell begins the life of every bee—worker drone, or queen In the case of the worker the egg hatches in three or four days into a small white grub and is then fed on a kind of bee-milk. On the fifth day the grub spins a silk cocoon and begins its pupa stage Certain individuals told off for the work then come and seal up the mouth of the cell with a cover which, however, lets in air Sixteen days later the grub has turned into a worker bee and begins to know its way out, sometimes assisted by the nurse bees The process is the same for the drone save that it takes twenty five days The queen is fed on special food called royal jelly, and the egg from which she comes is housed in a special cell These photographs are by H. Bastin.


J J Ward

CASE OF POISON DARTS WHICH IS THE BEE'S STING

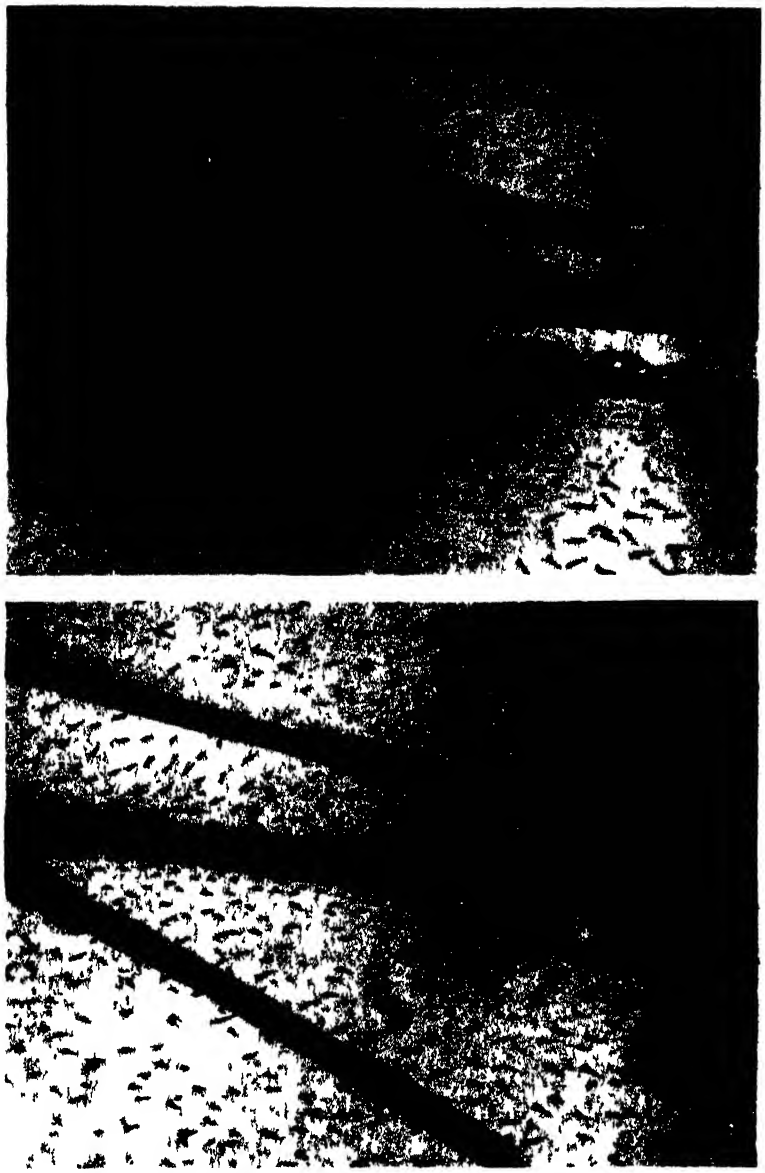
What is called the bee's sting is actually a sheath, or quiver (left), in which are two intensely sharp darts (centre). The sheath is barbed (right) like a savage's spear, and when driven through, say, the human skin, is held in place by the barbs. Then the darts drive up and down like pistons making a deeper and deeper puncture while formic acid is pumped from the poison-bag. All this takes place in a second or so. The bee, given time, can extricate the whole apparatus, but if brushed off is liable to be disembowelled.

every operation that arises in the crowded, complicated existence of the community. The worker bees build the bee city, producing from their own bodies the material necessary for its construction. The ancients believed that wax was gathered from the flowers. The fact is that wax is generated in certain glands situated in the underpart of the abdomen of the worker bees. When comb has to be built, a number of bees congregate in a dense cluster in the upper part of the hive, and there hang in a state of quiescence while the wax forms within them. At first the substance produced is very unlike beeswax, as we know it. It looks more like little transparent plates of mica, these protruding from beneath the horny scales of the abdomen, and often falling to the floor of the hive, where, if numerous enough, they show in a pale glistening drift. When comb-building the bee takes these plates out of their receptacles and chews them up, mingling an acid saliva with them the while until a soft, opaque plastic mass is formed. This is then moulded into the comb.

To the worker bees falls also the entire task of caring for and feeding the young larvae which hatch from the eggs laid by the queen. They produce from their bodies a white, dense liquid—veritable bee milk—and every larva in every comb cell must receive its due proportion of this food until it reaches full growth, when the worker bees seal it up in the cell. It then spins itself a silken cocoon and changes into a pupa, to emerge in due course as a perfect bee.

Other duties undertaken by the workers are the cleansing and scavenging of the hive, the establishment of a constant current of pure air through the hive by ranging themselves at the entrance and fanning their wings, mounting guard at the city gates to keep out strangers or robbers, and brewing the honey from the nectar brought in by the foraging bees. All these duties fall to the lot of the worker bees during the first fortnight of their lives, when they remain almost constantly at home. After that, the young worker gives up indoor duty and takes to the labour of the open fields. The duration of life of the worker bees may be anything from about seven weeks in summer time to as much as five or six months in the inactive close season. Mother bees have been known to persist for three or four years. The drones or male bees are produced in the late spring, live a merry, irresponsible life throughout the summer, their sole duty being to engage the young queens on their mating flight, and at summer's end meet with a violent death, the entire drone population of a hive being then killed off.

It has been said that the single mother bee in the hive is the parent of the whole colony, and here we are brought into touch with what is perhaps the most extraordinary fact in the whole wonderful bee economy. The mother bee seems to be endowed with the power of laying eggs which produce either drone or worker bees at will. In the active season she occupies nearly all her time in wandering over the combs and depositing in each vacant cell an egg. The drones, or male bees, are raised in slightly larger cells than the worker bees. The queen visits the two sizes of cells indiscriminately in the course of her busy day. But the bees ultimately emerging from the larger cells are invariably males, and those born in the small cells invariably turn out to be workers. The observer is left apparently with no other alternative but to believe that the mother bee can deposit either a male or worker egg at choice. To get light on this mystery, we must here examine



J J Ward

WONDERFUL WING MECHANISM FOR FOLDING AND FLYING
The bee must fold its wings within the limits of its own body measurement when entering cells Therefore the wings must be divided for work and united for flight The lower photograph shows the wing hooks on the posterior wings in operation and the upper the wing hooks disengaged for the position when folded

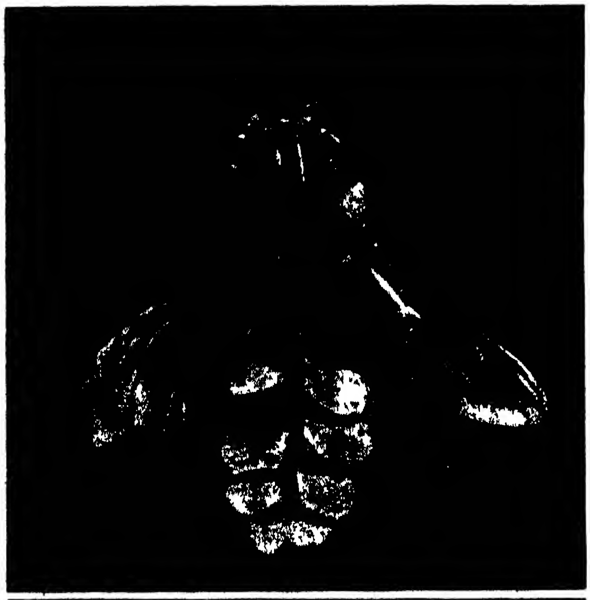
the life-history of the mother bee and of the workers in conjunction. The fact is they are of one and the same sex, the fertile queen, however, being a fully developed female, while the little workers are females with their reproductive organs so undeveloped as to leave them practically neuters. Yet each results from identically the same egg. Extraordinary as this fact seems, the explanation is in part quite simple. The difference between the bodily equipment of the mother bee and that of the little sexless worker depends entirely upon treatment and environment while in the larval stage. The worker larva is raised in a small cell, and is supplied with a bare minimum of bee milk during its period of growth. The queen is raised in a cell many times larger, and is throughout supplied with an unlimited quantity of this predigested food of a specially rich kind. The queen larva literally lives up to the neck in this food, called by bee-keepers "royal jelly," for the whole of this first stage in her life.

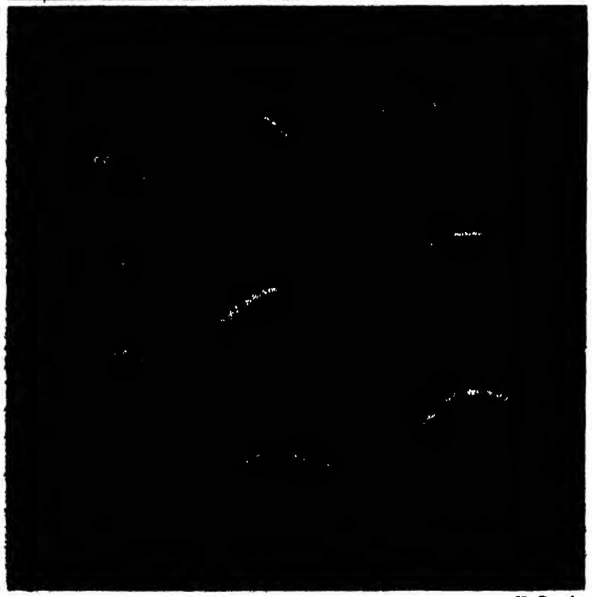
But the result of this treatment is not only larger size and full development of the reproductive organs in the queen. Many other differences are brought about. If the queen were merely a bigger and better-equipped worker bee, the thing would be understandable. But this is not so. Queen and worker differ in many other important particulars than in degree. The shape of the body is different, the worker's being short and blunt, while that of the queen is longer, tapering to a fairly sharp point. The queen's sidelong jaws are notched, while the worker's jaws are smooth-edged. The queen's tongue is shorter than the worker's tongue. The queen possesses not the slightest trace of wax-generating organs, nor has she any pollen-carrying baskets on her thighs. She is generally of a strikingly different colour from the worker bee. Her sting is curved, and longer than the worker's, while the worker bee's sting is straight. Above all, the queen's mental equipment is vastly inferior to that of the little sex-atrophied worker bee Shortly after her emergence from her royal cell, she makes one flight abroad for the purpose of her fertilisation by the drone; but thereafter, except when she goes off with a swarm, she spends her life entirely within the hive. She is fed by the worker bees, groomed by them, led by them over the combs on her interminable egg-laying rounds. She is, in fact, nothing but a living seed-barrow. That function she fulfils so completely that, during the height of the summer season, she will lay as many as 3,000 eggs a day and even more, giving out in 24 hours a weight of eggs equal to more than twice the weight of her whole body.

THE mother bee has indeed one strong mental attribute, and this forms one of the most striking dissimilarities between her and the worker bees. A queen bee is always ready for mortal combat with one of her own rank. It is always a duel to the death if two queens meet. On the other hand, the worker bees of a hive live and work together in perfect harmony.

It is hard to believe that all these differences between mother bee and workers are entirely due to super-feeding and unlimited room wherein to grow.

But that the two originate from eggs identical in character is provable by a very simple experiment which has often been repeated. A newly-laid egg from a worker cell has been placed in a queen cell, which is a comparatively large, acorn-shaped structure usually dependent from the edge or bottom of the comb. The egg found in the queen cell has at the time been transferred to the worker cell. The two have been allowed to hatch and grow to maturity. But the worker egg in the queen cell has invariably developed into a fully equipped queen bee, and the queen egg put into the worker cell has always produced an ordinary, stunted, sterile worker bee. The experiment can also be made with hatched larvae,

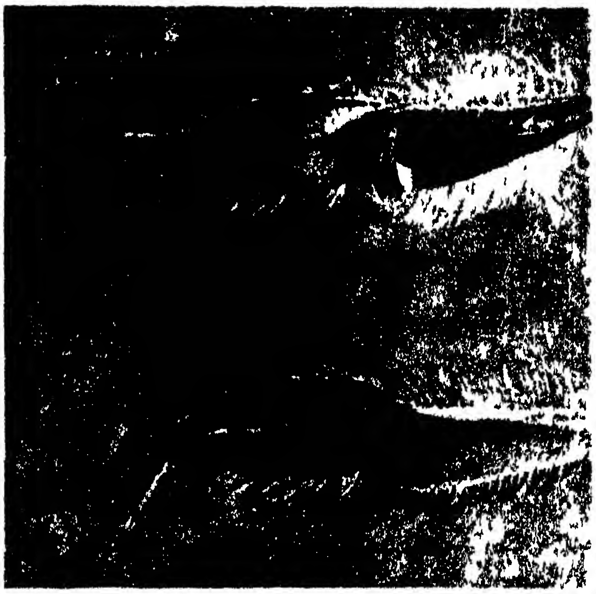




H. Bastin.

BEESWAX IN THE MAKING

When the honey-comb, which is formed of the substance called be swax, is to be constructed, the workers extrude wax particles from between the plates of their abdomens (top). The wax is at first hard (bottom), and it is then chewed to make it soft.



BEE'S LEGS IN DETAIL

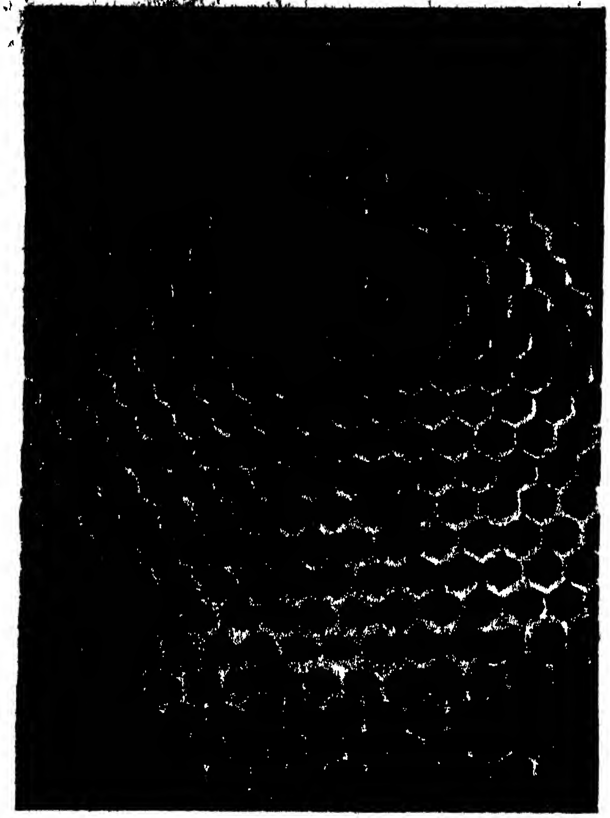
The binder pair have each a joint (bottom), hollowed out and furnished with hair to form a basket for pollen. The top photograph shows two parts of the legs, the lower the pollen combs and the upper the pollen basket itself.

provided these are not more than three days old, and in every case the result has been the same.

The drones, or male bees, however, are derived from eggs differing vitally from the eggs which produce queens or worker bees. The mother bee must, and actually does, deposit a different kind of egg in the drone cells from that which she lays in the worker cells. Is this due to intelligent choice on her part? And if not, how is it brought about? It must be said at once that a definite answer to the question has still to be agreed upon between modern students of honey bee life. But the writer is of opinion that the matter can be explained in the following way

In order to understand the position, it is necessary here to go rather fully into the extraordinary system of propagation of species appertaining to hive life.

It is not a matter of the simple coition of the sexes. The mother bee of a hive meets the drone only once



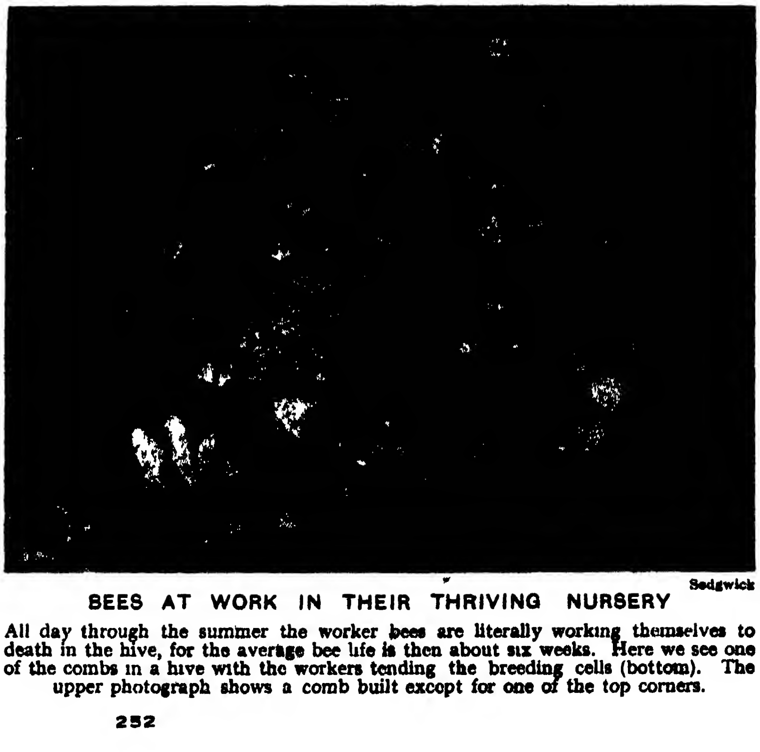
in her lifetime. The young virgin queen emerges from her cell, and spends a few days wandering about amidst the throng in the hive. The drones of her own hive take no notice of her, and, as far as is known, fertilisation of a queen by her own kindred never takes place, either within the hive or outside. Her single meeting with the drone occurs always in the open air, and, most probably, always at a distance from the home apiary.

There comes a day when the young virgin queen sets out upon the wonderful venture of her marriage flight. She breaks from the hive out into the sunshine, hovers for a few moments to mark the spot so that she will be able to find her way back again, then flies off straight across country swift and high. This occurs generally towards noon of a fine day when all the drones of the countryside are out and about, urged by the dominant instinct of their tribe. Their great, immensely powerful eyes soon detect the flying queen, and all and sundry at once give chase. The prize falls to the strongest and swiftest. A little later the young queen returns to her hive, and after a short time takes up her new duty of filling the brood-combs with eggs—work from which a whole new bee nation is now destined to arise.

But if, from inclemency of weather at mating time, or from any mischance, the young virgin queen fails to have commerce with the drone, she is still capable of fulfilling part of the duties of a mother. An unmated queen is able to produce eggs which will hatch out into fully developed bees; but—and here is the significant point to mark—those eggs laid by a virgin queen bee will result in only drones, or males.

Now we must look into the question of what actually takes place when the foremost of the pursuing drones succeeds in overtaking the young queen during her marriage flight.

A normal coupling occurs. But the fertilising essence of the drone does not pass into the queen's ovaries. It merely fills a receptacle which exists for that purpose near the entrance to the oviduct or passage by which the eggs of the mother bee are extruded. Every egg laid by a queen bee remains unaffected as far as the drone is concerned, until the moment of its passing across the mouth of the spermathecal pouch just described. And then it either receives, or does not receive, the male fertilising germ. Those eggs which pass the spermathecal duct unimpregnated, result always in drones or male bees. And those which receive the germ develop invariably into female bees—queens or workers, according to the nature and amount of larval food subsequently supplied in the cells. From this it will

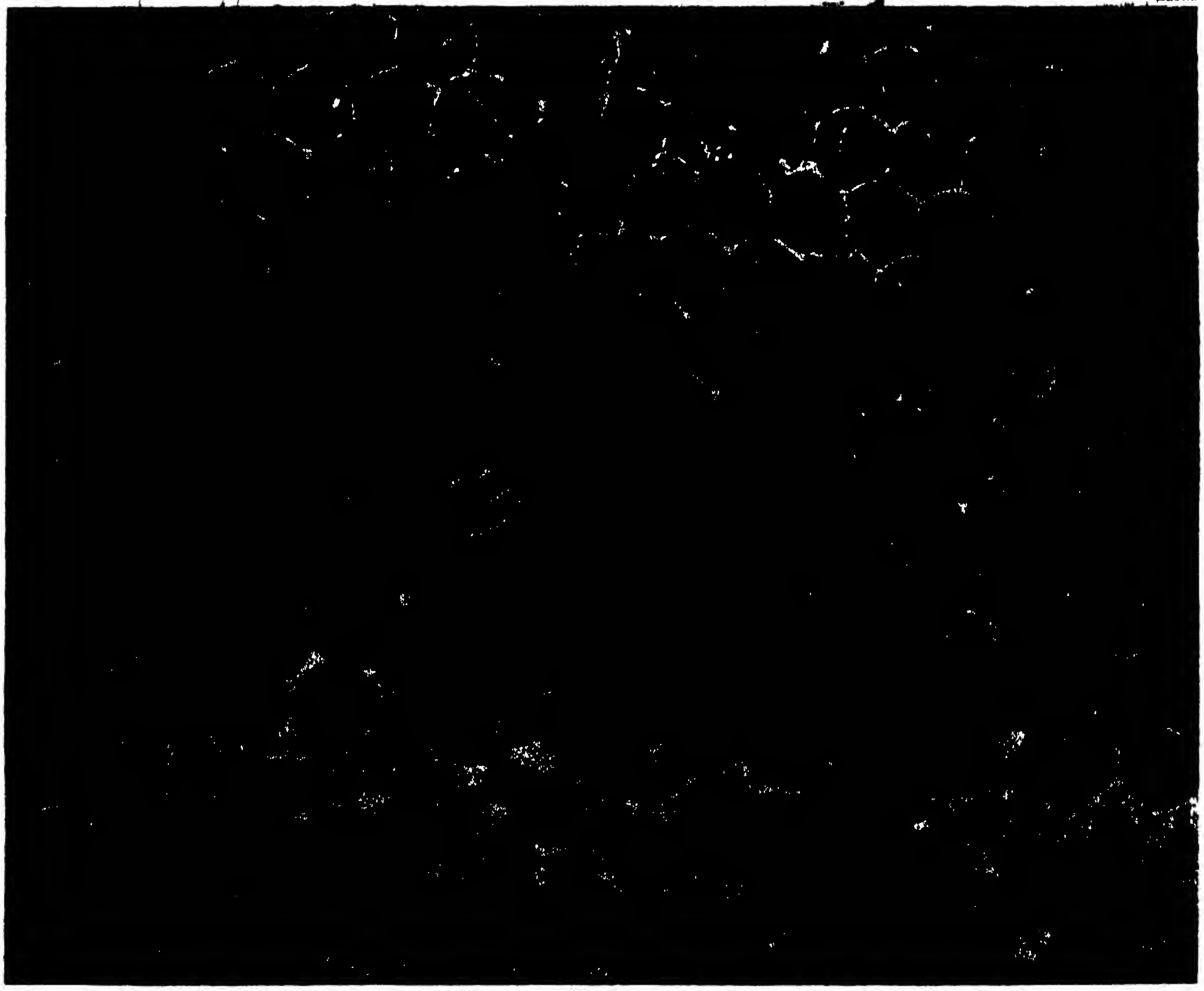


Sedgwick

BEES AT WORK IN THEIR THRIVING NURSERY

All day through the summer the worker bees are literally working themselves to death in the hive, for the average bee life is then about six weeks. Here we see one of the combs in a hive with the workers tending the breeding cells (bottom). The upper photograph shows a comb built except for one of the top corners.

Bastin



Sedgwick

THE QUEEN BEE ON THE COMB AND THE GRUBS IN THEIR CELLS

During the early summer the queen bee spends most of her time, not even pausing at night, in wandering over the combs (bottom) attended by servants who feed, clean and stroke her, depositing egg after egg in the cells. The term "queen" is really a misnomer. Mother bee is a more suitable name for this single individual of the hive is the mother of all its inhabitants. In the photograph she is the largest bee, and two of the attendants are beside her. The upper photograph shows some grubs half grown as they lie in their cells

be at once seen that while the females of the honey bee race are derived from both mother and father, the males are the offspring of mother alone.

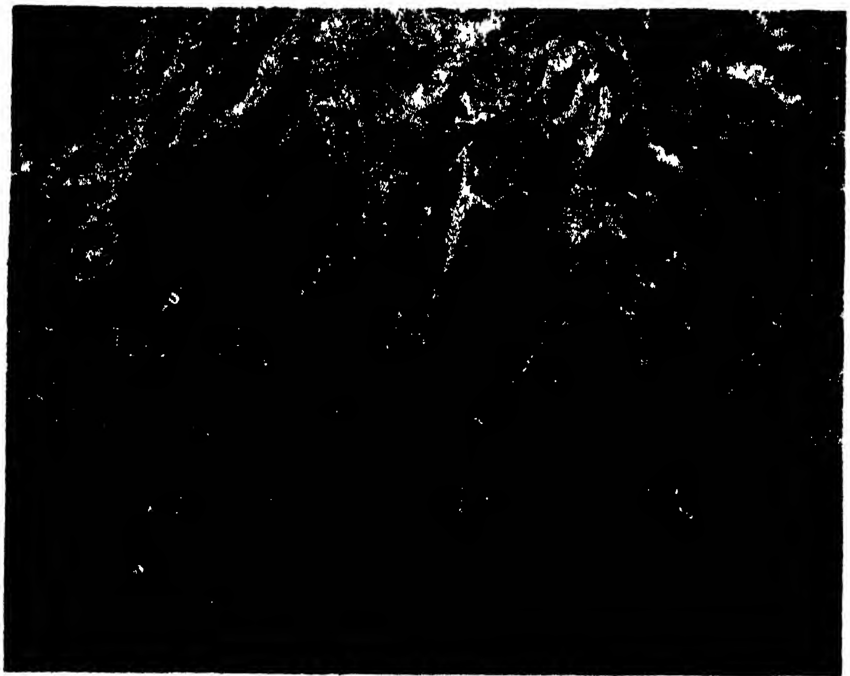
It has been necessary to go into these details at length because, unless they are known, the probability of what is now to be advanced cannot be appreciated. We have seen that a laying queen bee, passing across drone comb and worker comb in the course of her day's activities, stops at each empty cell, inserts her body therein, and deposits an egg, which we observe afterwards as a tiny white object like a microscopic grain of rice glued end-on to the base of the cell.

The drone comb cells measure about four to the inch, and the worker comb cells about five to the inch, measuring across the cells from side to side. Somehow or other only eggs which have had contact with the queen's spermathecal duct get into the small worker cells, and only eggs which have escaped that contact get into the larger drone cells. How is that state of things brought about?

In the opinion of the writer it is effected in a very simple, though none the less remarkable, way. When the queen inserts her body into the narrow worker-cell the abdomen assumes a necessarily straightened position, when the egg is forced against the aperture of the spermatic receptacle, and thus becomes impregnated. But when the queen is using the larger, roomier drone cell no such constriction occurs. The body retains its normal, slightly curved posture, and the egg escapes untouched. If this be not a true explanation of the mystery, a mystery it will probably remain to the end of time.

In any general examination of this sort, however brief, into the communal life of the honey bee, interest cannot fail to be aroused at that master stroke of practical communism—the way in which the bee republics carry out the multiplication of individual colonies, as well as the multiplication of bees.

Everyone knows that, in the height of summer, swarms leave the hives. A great number of the bees suddenly forsake the hive, fly about in a whirling, vociferating crowd for a few minutes, then gather together in a dense cluster somewhere hard by, generally upon a branch of a tree, where, unless interfered with by the beekeeper, the mass of bees will remain quiescent for the rest of the day and throughout the ensuing night, getting on the wing again some time during the following morning and then, as most usually happens, disappearing for good.



H. Bastin

Sedgwick

ACCIDENT AND INVASION IN A BEE COMMUNITY

The life of a hive of bees is not, so to speak, all honey, for besides liability to various destructive diseases the community may at any time be attacked by various enemies. If the comb becomes damaged it is promptly mended (bottom), but a less easily remedied difficulty is the invasion of the wax moth caterpillars (top) which spin a web over the whole comb

Without attempting an answer to the question, let us look into a bee-hive at some time before a swarm is due to emerge.

Up to that time, from the earliest days of spring, queen and worker bees have been straining every power together to produce a populous and prosperous state. There comes a day when the city is rich in labourers of all sorts. But as yet the population is wholly feminine. The males have been killed off in the foregoing autumn, because they are needed only for a few weeks in summer time, and the sternly utilitarian worker bee does not see why they should be sustained in idleness for the rest of the year. Now, however, the fiat goes forth that males are to be produced. The drone cells fill with eggs. Soon the deep, blustering voices begin to sound in the summer air. But something else comes to pass in the bee city. It is full now to the brim with winged people. It can expand no more. The common decision is reached—how, not the wisest among bee students has ever really divined—that the greater

The hive, finding itself overstocked with population, has sent out a certain proportion of its inhabitants to form a bee city for itself. In nature, this colony almost always establishes itself in some suitable place, most often a tree, at a considerable distance, as above described. But if the bee-keeper take the swarm, placing it in a hive of its own, and even stationing it close to the original home of the swarming bees, these bees will not return to their old hive. They have done with it, apparently forget all about it, and set themselves to furnish their new quarters as though the old home had never existed for them. In a month or two the colony will have established itself as a separate stock fully as large as the one from which it was derived.

Now what is this swarming procedure of the honey bees unless it be the carrying through of a policy of compulsory emigration—the adoption of a principle in citizen-science to which even the supposedly enlightened human race has not yet aspired ?

J J Ward

MOUTH PARTS AND PROBOSCIS OF WORKER
A bee's mouth (bottom) consists of outer and inner jaws, the tongue or proboscis, and on either side of it two labial palpi which form a case for the tongue when it is not in use The tongue (top) has an end shaped like a spoon

H Bastin

TREASURE FROM A FOXGLOVE BELL

It is not always realized that a bee's body is covered with minute hairs. These catch the pollen as the insect moves about a flower. The pollen is then brushed off and moistened into a little pellet, and deposited in the pollen basket on the hind legs

part of its inhabitants shall emigrate, to set up an entirely new commonwealth elsewhere

What then happens cannot be too simply told, because it is so wonderful At the time a hive begins its preparations for swarming, it may contain anything between 30,000 to double or treble that number of worker bees. Perhaps a little more than half of these, when the order is given to depart, will at once rush out of the hive to constitute the trekking host. The rest will remain busily engaged on the work of the city, going in and out, and, to all appearances, taking not the slightest notice of the frantic proceedings going on. It is difficult to explain this state of things on any other hypothesis than that every bee in the hive has long known which among them is to stay and which to go.

Be this as it may, it is certain that preparat ons for the exit of the swarm have been in train for some time. The prospective colony must take with it a mother bee, or it will not be able to continue its separate life. And there must be no doubt of her fecundity. So, to give the outgoing bees every chance of making good in the independent life before them, it looks here as if the parent hive deliberately accepted a risk. Queen cells are now constructed, and young queens are raised Several, indeed, may have come to full maturity by the time, and even before the time, the swarm issues. But they will not be permitted to emerge from their cells before the day chosen. Guards are placed over these cells, not only to prevent the young queens breaking out before they are wanted, but also to prevent the old queen getting at and destroying them, which she is always eager to do.

So things go on until the appointed day arrives for the departure of the swarm. And then it is the old queen, with her proved capability, known to be at the seasonal height of her egg-laying powers, who is sent forth with the swarm. The parent hive elects to remain queenless until one of the young virgin queens, who is now allowed her freedom, has survived the hazard of her impregnatory flight, and proved her claim to full motherhood. Then she is permitted to destroy all her still incarcerated rivals, the risk to the parent stock being now a thing overpast.

In the construction of the combs, either for the storage of honey and pollen or as nursery quarters for the young larvae, the honey bee displays perhaps an even more amazing ingenuity than is seen in any other of her works and ways.

And, first, as to the choice of building material. In beeswax, as we see it wrought up into comb, we have a substance fragile, delicate, light as air; and yet the combs are capable not only of supporting, but of suspending, a dead weight thirty times as great as their own. There was nothing obtainable in nature, we may be assured, of the same quality, or the wonderfully astute worker bees would have pressed it into their service. A bee-hive is a fortress with only one aperture as means of entrance and egress for all purposes. The space within is definitely limited. Economy of this enclosed area must rule every work. A storehouse had to be built. Cells for the nurture of the young bees had to be provided. The only way was to employ a material that, while of the strongest, would occupy the least space. This substance the bee finds in her own body in the wax which, for ductility, strength, and high resistance to heat, entirely surpasses any other material of its kind whatsoever that is known to science.

THE next stage in the problem of fitting up the interior of the bee dwelling was to determine the most suitable design for the structures needed, so that, while efficiency was secured, the utmost economy in space and material was also effected. On looking into a bee-hive it is seen that the interior is completely occupied by combs attached to the roof, and hanging down side by side to within a small distance of the floor-board, the combs being about a quarter of an inch apart throughout. Each comb consists of a double wall of cells hexagonal in shape, the cells being horizontally placed with their mouths opening outwards, and their bases meeting together in the centre of the comb. Thus one central vertical layer of wax is made to serve the purpose of closing the bottoms of all the cells in the comb, right and left.

It is evident that a considerable saving in material is here effected. In the first place, by making the cells six-sided in form, useless interstices between the

cells, which would require to be filled with wax, are avoided. Then, in placing the two combined walls of cells back to back, not only is a saving made of the wax which would be needed for one entire set of cell bases, but the builders are enabled to reduce the width required for the whole comb. A glance at a piece of comb will immediately make this point clear. The bottoms of the cells will be seen to be closed not by a flat plate but by one of shallow pyramidal form, each cell base consisting of three diamond-shaped pieces joined together at their edges. This ingenious method of construction serves not only to add strength and rigidity to the comb, but it allows the pyramidal bases of the cells to be alternated, much as if the edges of two saws were fitted together. The result is that the total width of the comb, made up of two horizontal cells of the necessary length placed end to end, is visibly reduced, and a corresponding saving of material effected.

But by the adoption of this system of cell base construction, it is not only in the reduced width of the comb that saving in material is achieved; the weight of the entire structure can be safely lessened. If a piece of comb be held up against the light, it will be seen that the cells of one side do not coincide with the cells on the other. In a given cell, each of the three diamond-shaped plates of which its base is formed helps to close a different cell on the other side. The apex and three ribs of each hollow pyramidal cell base form foundation lines on which the cell walls on the other side of the comb are erected. Thus all cell walls throughout the comb rest on an arch, and all cell bottoms on a triplex girder. The result achieved by this astonishingly ingenious constructive system is that the quantity of material needed in the building of the comb can be reduced throughout to an absolute minimum. The thickness of the waxen cell walls and basal plates need be no more than will suffice to retain the honey or support the weight of the larvae. And this thickness has been found, by careful measurement of many combs, to be actually only the hundred-and-eightieth part of an inch. Is there anywhere, in the works of either nature or man, a more perfect example of the triumph of mind over matter?

Inevitably at this stage we are brought up against the old controversy as to the nature of the quality called instinct which is supposed alone to govern the lives of creatures other than man. The point comes up crucially in any and every attempt to deal with the marvellous commonwealth of honey bee life, and cannot be passed over here. It has been contended that there is nothing in the construction of the combs in a bee-hive, wonderful as it admittedly is, which warrants an assumption that the creatures building the combs are endowed with a higher order of intelligence than what is implied by the word Instinct. The fact that comb cells are found to be hexagonal, or six-sided, in shape, is asserted to be nothing out of the common, because, by a well-known law in nature, cylindrical or spherical objects brought closely together always tend to assume that form, and that, in fact, the cells of a honey-comb do so automatically by this law of mutual interference without any design on their makers' part. If a bottle be tightly filled with damp peas, it is pointed out, the peas, in swelling, will lose their round shape and take on a many-sided form.

Now this is quite true. But there is an essential difference between the swelling of the peas in a confined space, and the growth of the honey-comb, which takes place under perfectly free conditions. Moreover, one vital circumstance in the comparison is either overlooked or ignored. The peas are each separate, self-contained objects, and therefore capable of interfering with each other. But there is no such thing as a single, separate comb cell. Each hexagonal chamber in a comb shares its parts—its six enclosing sides and its threefold base—with no fewer than nine other such chambers with which it is in contiguity. And where there is no separate existence, there can be no mutual interference. The pressure theory, as accounting for the hexagonal shape of the comb cell, here obviously goes for nought.

But there is another circumstance in the method of construction of the comb by the bees, which, in itself, appears to be irrefragable evidence in favour of intelligent design rather than of what is called instinct, as actuating its construction. If a piece of comb which is in course of building be examined it will be seen that, while the upper part of the comb is finished with all its six-sided cells on each side complete to their rims, the extreme lower edge of the comb has as yet only the cell bases entirely laid in. This reveals the fact that, when comb-building, the bees make the six-sided bases of the cells first, erecting upon these, as upon a foundation, the hexagonal partition walls. Our own eyes prove to us that the hexagonal principle has existed in the minds of the builders, and is translated into fact in the making of the cell bases, before the walls are begun.

Yet, in disposing of this fallacious pressure theory in the construction of honey-comb, we only find that a greater mystery than ever has loomed above the horizon. For how did the astute little worker bee hit upon the hexagonal shape as the best for her comb? She could have made the cells cylindrical, but when fitted together in the comb these would have left useless interstices which would have had to have been filled up with wax. The hexagon has the double advantage of perfectly filling a plane surface, while being as nearly cylindrical as is needed to contain the round-bodied larvae. If we are not prepared to admit that it was some sort of attribute nearly allied to reason which led the honey bee to adopt the hexagonal form of cell we must at least concede something to those who feel that, in these days of increasing knowledge of the life of the bee and other creatures living in communities, the old, rigid dividing-line between reason and instinct is becoming more than a little shaky and ill-defined.

A. H. Willford

FEATHER DEVELOPMENT IN THE YOUNG BARN OWL, FROM NESTLING TO FLYING BIRD

When we come to examine the down on the young nestling we are reading part of the wonderful story of evolution. For the young bird, in the course of growth from embryo to fledgling, repeats the various stages of its development through the ages. And the story of this development goes back through thousands of centuries to the time when the growing tree of life divided one of its branches, the one to form the reptile and the other the birds. What were once characteristics of adult birds appear and are gradually discarded by each successive generation as it grows. On the left is a three-weeks-old bird, centre, a bird at six weeks, and right, at eight weeks. In other words, this is a repetition, in two months, of an aeon of development.

Chapter XXVI

The Childhood of Animals

By Frances Pitt

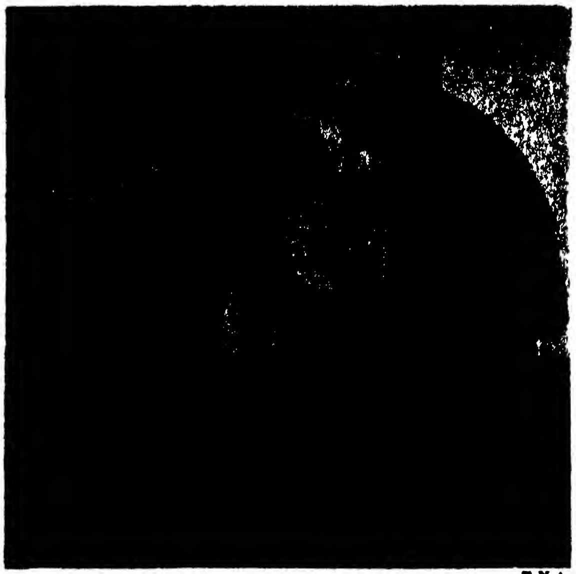
Author of "Woodland Creatures'

No stage in the life history of a wild creature is more interesting than its youth. Moreover, young animals, whether wild or domestic, are always a joy to watch, from a fluffy kitten playing with its mother's tail to a little seal sporting around its parent as they float in the sea.

Once, in the Shetlands, I was privileged to watch some seals and their young ones at home in a sheltered cove. They were the so-called common seal (*Phoca vitulina*), whose young ones are born in May, and as it was then the latter part of June, the youngsters were able to swim well. My friend and I lay upon the cliff top and gazed down into the little bay some hundreds of feet below. Great stacks of rock guarded the sanctuary, which was inaccessible to all save the wild creatures and the waves that rolled in, to crash in thunder upon a narrow beach. On this beach lay several seals with their pups beside them, and in the water were others, among them four old seals accompanied by young ones. It was very pretty to watch the little seals playing about their dams, as they all floated so contentedly in the green waves. One youngster kept playing about its mother's head, just like a puppy teasing a long-suffering old dog, but she paid no attention to it. Soon an old seal tried to take her baby ashore; she waited until a big wave came, when she let the breaker carry the two of them shorewards and wash them up the beach. The moment she felt ground beneath her she heaved and humped herself up the shingle out of reach of the succeeding wave, but her inexperienced child was not quick enough, and was carried back again. Turning round, the old seal saw what had happened, and quicker than can be told had dived in again. Once more she brought the little one shorewards, but again and again the baby was washed away. It seemed to enjoy playing in the waves, and it was apparent that it was having a useful lesson in water craft. Six times in all did that persevering mother endeavour to get her inexperienced pup up the beach, and at last it seemed to grasp the need to hurry, humping itself up the shingle at her side, to the shelter of a great black rock, where, high and dry, the old seal rolled on her side, and the baby, creeping up to her, proceeded to help itself to the refreshment which it no doubt needed. Thus they lay in the sunshine, unaware of the watchers so far above, and I thought about the way mother animals train their young.

We are accustomed to talking of animals as acting by instinct, and do not always realize the amount of education and experience the young animal has to acquire to fit it for the battle of life. Just as the human child has to go to school to acquire knowledge which will enable it to play its part in the world, so the wild creature, despite a considerable outfit of inherited impulses and predispositions to behave in a certain way under certain circumstances, has to learn how to get a living, and the best way to cope with the circumstances of life.

A chick, for example, when first hatched, has an inherited impulse to peck at anything which is bright enough to catch its eye, but it has no notion what is good to eat and what is not. It will as readily peck at a red thread as a red worm. It has to find out and learn from experience what is good to eat and what is not. The old hen does her best to teach her chicks what is good. When she finds any tasty bit she clucks to them, calls them to her, and by picking up and dropping the food, and again picking it up and holding it in her beak, demonstrates that it is good to eat. Thus chicks soon learn to discriminate, but there are many things they have to find out for themselves, such as the different kinds of grubs that are nice and those which are not. I offered some small chickens the black and yellow caterpillars of the magpie moth, which are usually avoided by insect-eating creatures, having evidently an objectionable taste. The chickens in their ignorance and innocence ran and picked them up, but they dropped them as hastily as they had seized them, and spent some minutes wiping their beaks. The caterpillars must have been very nasty, because the chicks remembered and refused them when offered the same larvae again two or three days later.



E.N.A.

BEAR MEETS BEAR

When a small bear enters the world, usually in January or February, it is a complete replica of its parents on a small scale, unlike many young animals. Here we see a brown bear being introduced to an American black bear

There was an otter cub that I saw experience a

Natural History N Y

LITTLE KOALA AND ITS MOTHER

Australasia is the only haunt of the koala, which lives in the eucalyptus trees and carries its young when just born in a pouch like the kangaroo. Later the young one learns to cling to its mother's back, as we see

similar unpleasant lesson. It was one of the two tame cubs which I had hand-reared and which was running free about the garden. The cub was turning over stones in search of slugs—a favourite amusement of the two otters—when she exposed a toad that had hidden itself beneath a brick. She was greatly delighted with her find, dragging the unfortunate toad from its hiding-place, and growling furiously at her sister when the latter came near, before carrying it off to play with and throw about. Of course, the toad immediately made use of its one and only defence, emitting that acid secretion which causes dogs such distress when incautious enough to pick a toad up. It was but a moment or two before the otter flung her treasure from her, and began to paw her muzzle and mouth. A second more and she was in a frantic state, rolling on the turf in great distress. It was some time before the pain subsided and her peace of mind was restored, but she never forgot the lesson, and in future handled toads with the greatest circumspection. Ever after a toad was taken by its toe, carried with care to the nearest water, and there washed until fit to eat.

In the otter, which is a remarkably intelligent animal, childhood lasts for some twelve months, during which the cubs go out fishing and hunting under the care of their mother, learning the ways of the river world under her tuition, and teaching themselves much river craft during their mad romps and wild games, for of all light-hearted cheerful youngsters otter cubs are the highest-spirited.

I know no more delightful sight than young otters at play, dashing through the water in porpoise-like dives, to catch one another up, face about as if in mortal anger, grab each other by the neck, and whirl over and over quicker than the eye can follow ; only to part once more, and continue the mad chase from water to dry land, where one catches the other by the tail, pulls it up short, and the two tumble head over heels, to roll in a desperate embrace, before dashing back to the water, diving in, and splashing it far and wide as they roll, then turn and twirl till exhausted.

Nearly all young animals play more or less, from the lambs in the springtime racing in the meadows and butting one another with lowered heads, to wolf cubs in their far-off forest den, or tiger cubs in the jungle. We can say that young animals are bubbling with the joy of life, and in considering the biological significance of play it may be added that it acts as a safety valve, letting off that superabundance of energy which is the prerogative of the young. The young creature, whether bird or mammal, wild animal or human child, is like a well-stoked steam engine ; if it cannot let off steam sometimes something must burst, and play is the safety valve of the young animal ; at

SLOTH BEAR WITH ITS BOTTLE

The will to live is well demonstrated in this photograph of a young sloth bear being artificially fed. The intense way in which it clings to the source of its food shows it determined already at this early age, to keep a grip on life

the same time ensuring that everything shall run sweetly and be tuned up as perfectly as possible when it is called upon for the long steady work of maturity.

It may be taken as a rough rule that the more intelligent an animal is, the more playful and entertaining it is during its childhood; for example, the monkeys, especially the higher apes. And another rough rule is that the longer the average span of life of the individual, the longer it is reaching maturity, hence the longer its tutelage and the period it is dependent on its parents. Again the great apes are a good example, with the long childhood of the young and the dependence of the latter on the old ones. Taking both these rules together, we may add that the higher the creature the more important looms its

childhood and early training, until we come to that of man, who starts life with the most meagre of instinctive outfits, and spends many years in preparation for maturity and the battle of life.

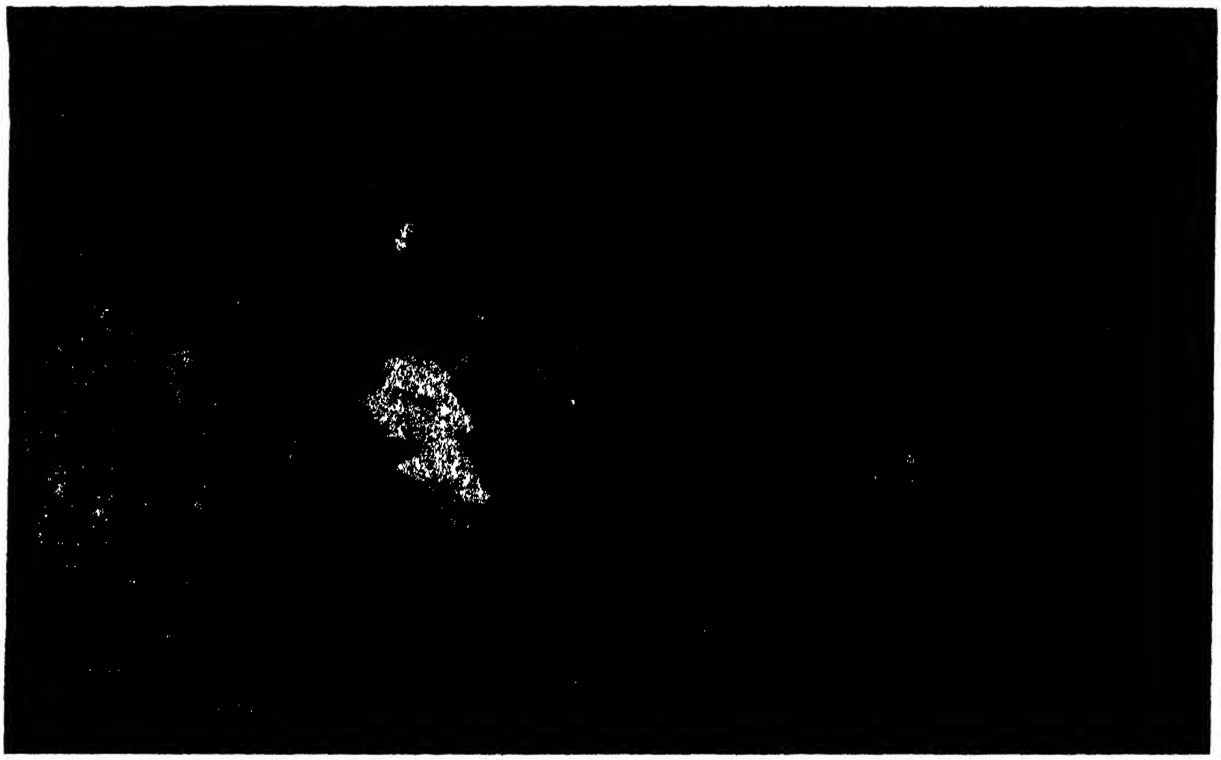
In contrast to man, the great apes, and other creatures with a long childhood, there are many animals in which the period of youth is reduced to a few weeks or months, and in which the time for play and education is likewise brief. Most of the birds, of course, grow up very quickly. The necessity of their hurried lives compels it. This does not allow them so much time to gain experience, but they have good outfits of instincts, so that in unexpected situations they are often able to act, as we do when we move habitually "without thinking"!

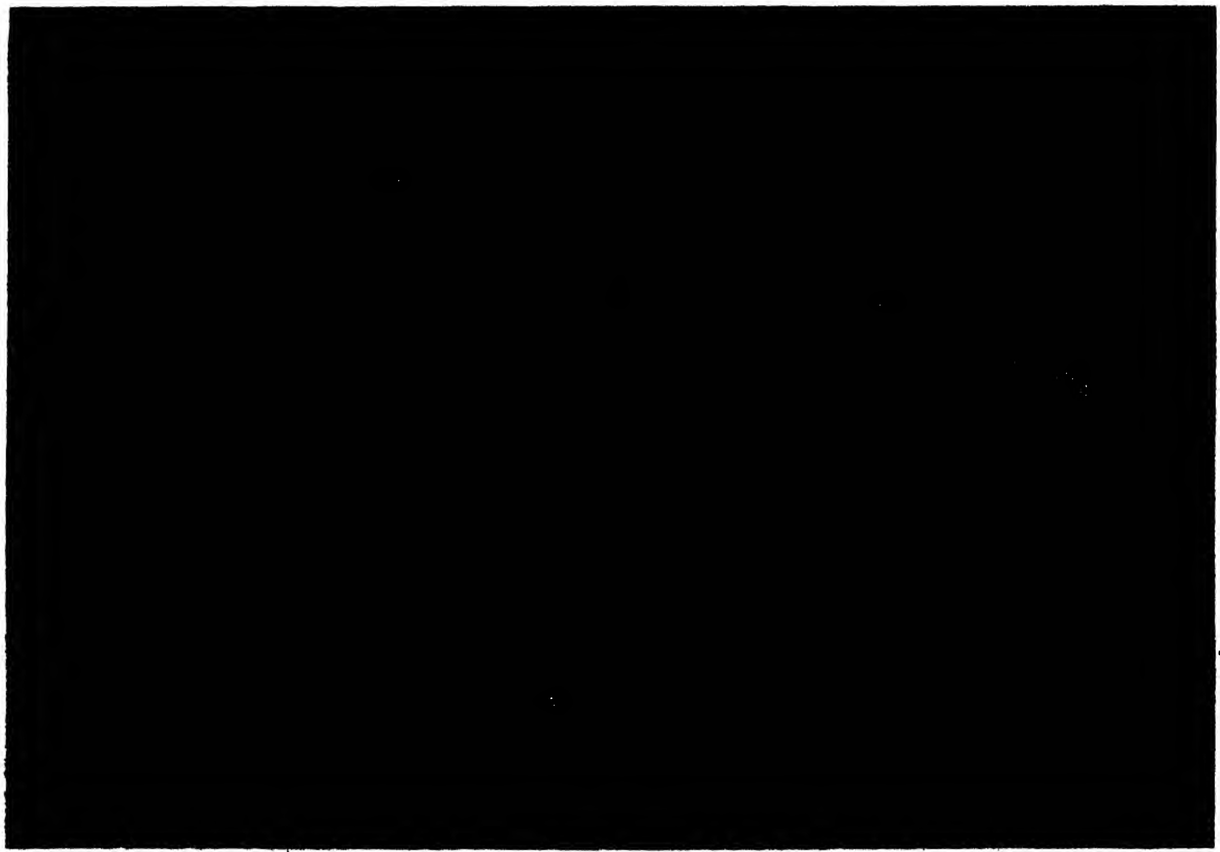
But what of the babyhood of birds? Well, first of all how it varies, from that of the helpless "squabs" of hedgerow birds, entirely dependent on the tender care of the old ones, to the self-sufficient chicks of the Australian "bush turkey" (the megapode, of which there are several species), which lays its eggs in a heap of decomposing vegetable matter, scratches this over the eggs, and leaves its treasures to be hatched in this natural incubator, taking no interest whatever in the welfare of its offspring. The latter, from the moment of hatching, can look after themselves, and never know what real childhood means.

How different the tender solicitude of most mother birds! If their chicks are only a short time beneath their care they, at any rate, spare neither love nor trouble while they have them, working their feathers to tatters to supply them with food. The most devoted of all are, I think, peahens. The peafowl not only takes the greatest care of her newly-hatched chicks, but, literally, keeps them beneath her maternal wing for an exceptionally long period. It is a most amusing, not to say ridiculous sight, to watch a peahen taking her nearly full-grown chicks up to roost at night. She flies up first, calling her family to follow, which the two or three youngsters hasten to do, when they creep to her side, cuddling close to her,

DRY-NURSING A WART HOG AND A LION CUB

Often it is necessary to bottle-feed young animals at the Zoo and here we have a young wart-hog (bottom) taking its nourishment from the keeper, while above is a lion cub gripping its bottle in a determined sort of way. Notice that the lion cub is striped when young like an adult tiger. These stripes gradually disappear with growth

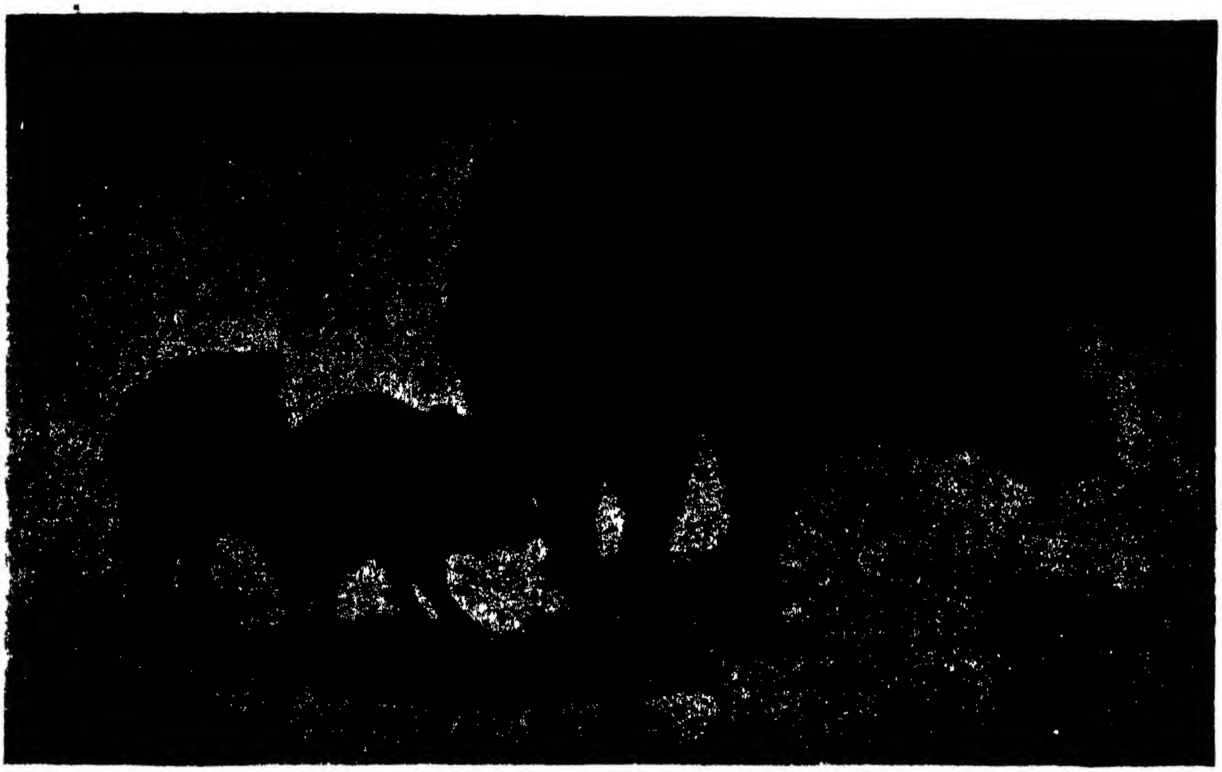




Neville Kingston

BISON CALF AND A YOUNG LLAMA WITH THEIR MOTHERS

Among the characteristics of the bison—often quite wrongly given the name of an entirely different animal, the buffalo—is the shaggy head. This, it will be noticed, is not possessed by the calf, which in consequence exhibits quite a different physiognomy from that of its parent. The upper photograph in this page shows us a young llama which is very unlike its parent, but much more resembles a very long-legged kid. Its colour, too, is different. In both these cases there is a contrast to animals like the bear, which resemble their parents from the start



Neville Kingston

WILD HORSE WITH A SHORT INFANCY AND PECCARY WITH A LONG ONE

Peccaries, like the wild pigs, go about in herds and are afraid of very little., Therefore the young can afford to remain helpless for two or three weeks. They are usually born in some fastness in rock or thicket, and there may be ten in a litter The upper photograph shows a collared peccary from South America In the lower photograph we have specimens of the Mongolian wild horse—a mare and her foal Wild horses lead a nomad life and the foals must be able to follow their mothers almost at once and grow up quickly

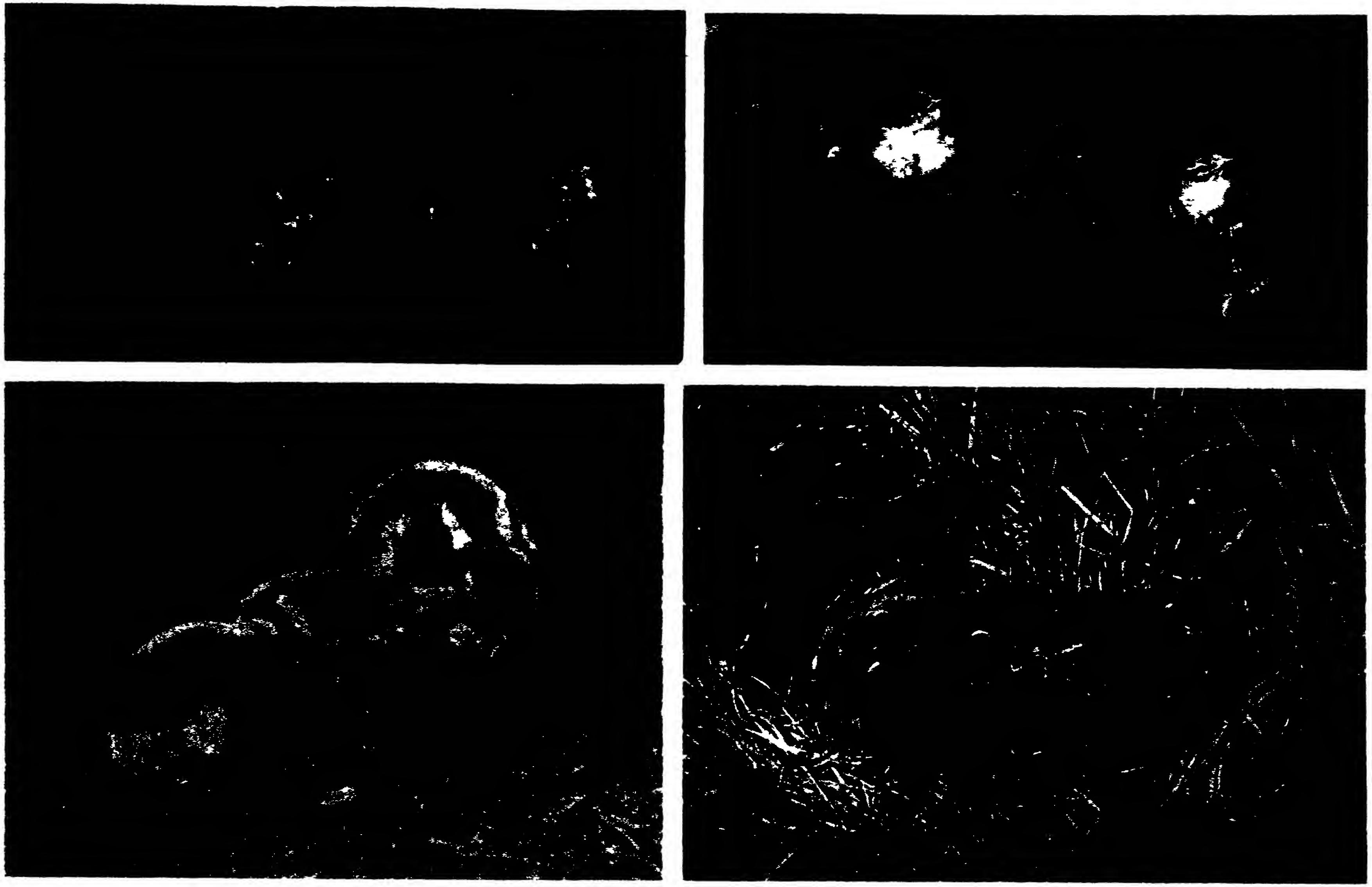
Neville Kingston

LEOPARD AND LION CUBS, DOCILE ONLY WHILE YOUNG

Maturity is reached by the leopard (bottom) in about two and a half years and by the lion (top) in about five years, that is to say that growth may continue until such a period after birth, although reproductive powers are developed earlier The cubs of both these dangerous animals are naturally playful and affectionate in youth, and this state of things holds good in captivity But when full grown the natural tendency to be fierce in an unfriendly world usually gets the better of their friendly feelings towards man at some time or other

HOW ALLIGATORS AND SCORPIONS LOOK WHEN YOUNG

At ten months many animals are adult, and many more three parts grown. But the alligator is slower in development, for it is comparatively long lived, and has only reached the size we see here ten months after hatching. (The birth of a crocodile, the alligator's near relative is the subject of the colour plate facing page 96.) Maternal care hardly seems to go with anything so unpleasant as a scorpion, yet the mother carries her young family about on her back (top) to which the little ones contrive to cling securely



A. H Willford

WHEN THEY ARE VERY YOUNG: BEAST AND BIRD CHILDHOOD

Young rabbits grow very quickly, and begin to breed and produce more and more rabbits at about the age of six months. All this is necessary for the continuance of the race of rabbits, which are a convenient form of food to so many beings from man to weasel. Three young ones appear in the lower left hand photograph Hares (bottom right) take a little longer to grow than rabbits and are not properly adult for about fifteen months, though they are ready to pair in twelve. During the first year they are called leverets (a name derived, through the French, from the Latin word for a hare, while "hare" is from the Anglo-Saxon). The upper photographs show (top right) young willow warblers and (top left) infant thrushes.

is the same in the case of the puma, which suggests that these animals are descended from beasts that were spotted or mottled. A similar change is seen in certain young deer, which begin life beautifully dappled, and then lose their spots; but in their case it is possible the spotting may be an instance of protective adaptation, serving as camouflage when the dam has to leave her new-born fawn hidden in the undergrowth. Whether this latter argument accounts for the striped young of animals, such as the tapirs, is another question, but the prevalence of stripes and spots among these

one under either wing, she spreading her wings so as to cover her great offspring now almost as big as herself. This she does every night until the succeeding spring, and I have seen an old peahen trying thus to protect a big cockerel who was larger than herself. The childhood of the peacock is certainly a lengthy one compared with the brief one of the majority of birds, but it must not be forgotten that he takes some time to grow up, not acquiring his adult plumage until three years old, and only then developing the full glory of his eyed train. He lives, however, to a good old age, as is usually the case with creatures that are slow to reach maturity.

It is the same with many of the gulls, such as the great black-backed gull, which passes through several seasons as a grey-brown speckled bird before assuming the well-known white livery with dark mantle.

There is a common saying among biologists that the individual recapitulates the history of his race—that is, that in the course of his life he passes through the stages that have marked the evolution of his species. In many instances this recapitulation is blurred by the need of special adaptation of the young to their environment, but in other instances we can discern it more or less plainly, as in the grey-brown plumage of immature gulls and the speckled feathers of the young peacock. There is every ground for believing that in these cases we are getting glimpses of the ancestral plumage of the gull and of the peacock, that the snowy feathers of the one and the gorgeous-eyed plumes of the other have been evolved from quite ordinary beginnings.

This wearing of old-time clothes by the young is also seen in other and widely divergent species, even among the mammals, such as young lions and tigers. Here we have a queer contrast not only between youth and age, but between cubs of these comparatively nearly related animals. Tigers, as we all know, are handsomely striped, yet tiger cubs are born with plain coats, only developing their characteristic markings as they grow older. Now lions, with their plain jackets, start life with decorations, the baby lion bearing marks on its coat! It

F. W. Bond

OPOSSUM AND HEDGEHOG FAMILIES

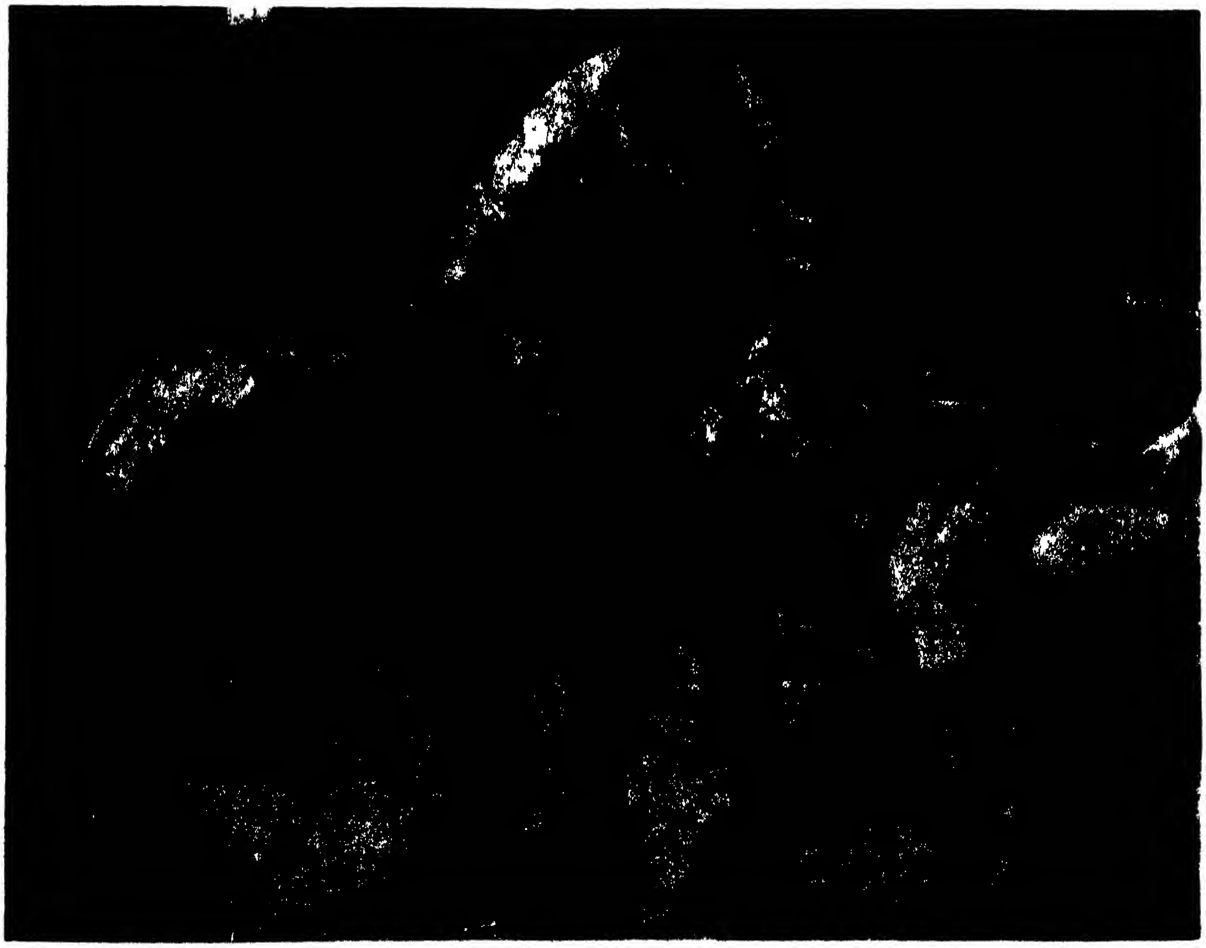
Such animals as take their young about with them have each found the best way of doing this. Below is an opossum, a liver in trees, with offspring securely clinging to its back. Above is a hedgehog taking its six children for a walk.

F. W. Bond

Keystone

IBEX KID CONFINED IN NATURAL SURROUNDINGS, AND THE BLACKBOK

The young of ruminants or cud-chewing animals are subjected to a life where early activity is imperative. Such animals as the ibex (bottom) or the South African blackbok (top) have often to travel long distances for water and depend on their speed and agility in escaping from enemies. Also the feeding grounds have constantly to be changed and so we find that kids are soon able to follow their mothers among the rocks and crags of their mountain homes. The ibex, formerly common in the Alps, is found in Central Asia, Arabia and Abyssinia.



RHINOCEROS, ELEPHANT AND WALRUS IN THEIR YOUNG DAYS

While it has been naturally difficult to study the habits of the wild rhinoceros, it is known that the young take a long time to mature, and specimens of six or seven years old have been seen still running with the mother and suckling. The elephant does not use its trunk for drinking or feeding until it is some weeks old, and is active very soon after birth. But the mother uses her trunk constantly for stroking her little one. A young walrus (top) is easily tamed, for it is very dependent in early years, and in the wild state stays long with its mother

creatures lends support to the idea. But the markings are lost as the young animals proceed with the business of growing up.

Reverting to plumage changes in young birds, with their striking contrasts, often more striking than those of the spotted lion cub that becomes plain, or the plain tiger cub that becomes striped, what could be more surprising than the change of the dingy brown cygnet into the snowy swan. Here we almost certainly have a recapitulation of the history of the race, and of the evolution of a white bird from what was originally a grey-brown one. But does this equally apply to the case of the black swan, for here the facts are reversed? In the latter the cygnets are white to start with and become black as they grow older! Whether this is adaptation, or recapitulation, I cannot say. However, there are many and obvious instances of special adaptation among young birds, especially among the downy chicks of such species as nest in the open, whose young leave the nest soon after hatching. The young golden plover is a good example. This chick leaves its nursery as soon as its down is dry, following its parent out into the heathery waste, where danger stalks abroad in the shape of raven, hawk, fox, and wild cat. Here its only protection is invisibility, and thanks to its coloration it is invisible. When anything alarms the parent, she utters a danger cry, at the sound of which the chick crouches flat, remaining as motionless as a stone. The old bird flies off, trying to draw the enemy after her, even feigning injury to do so, but the little one still lies as if frozen, and with its perfect adaptation of colour and markings blends admirably with the ground where it rests.

I was once hunting for young golden plover, and had been doing so for half an hour, the distress of the old birds assuring me I was close upon the chicks, when I almost stepped on what I thought was a small tuft of green sphagnum. It looked like a bit of moss lit by sunlight, but just in time I realized it was a plover chick! Its lovely golden green and black-spotted down so exactly resembled the play of light and shade on moss that it was bound to be overlooked. It was the merest accident I had not overlooked it and stepped on it!

F. W. Bond

TENTACLED SNAKE WITH NEW-BORN OFFSPRING

Birth finds the snake already equipped for life, and, save in one or two species, there is no parental care devoted to it. The young are exact duplicates of their parents except that in some species the markings may vary. Altering conditions, especially of temperature, affect the growth of individuals so that it is practically impossible to judge the age of a snake, not in captivity, by its size. The photograph shows the young of the small tentacled snake shortly after birth, with their parent.

Nevil e Kingston

It is the same with other chicks which resemble their surroundings; red-brown woodcock chicks among oak leaves; young gulls in iron-grey upon the grey rocks; snipe chicks dressed in tortoiseshell down to resemble the peaty-black mud of the bog, lapwing little ones in their grey and dark grey camouflage which just resembles the shadows between the herbage on the meadow; and many a score of other young birds that are specially dressed for hiding.

Then at the opposite extreme are young birds that begin life in holes or sheltered nests, and have no use for downy garb or camouflage effects, such as the naked squabs of the woodpeckers and kingfishers, which lie safely in the dark until they can assume the dress of maturity and fly forth into the world fully equipped as perfect or nearly perfect editions of their parents

W. S. Berridge

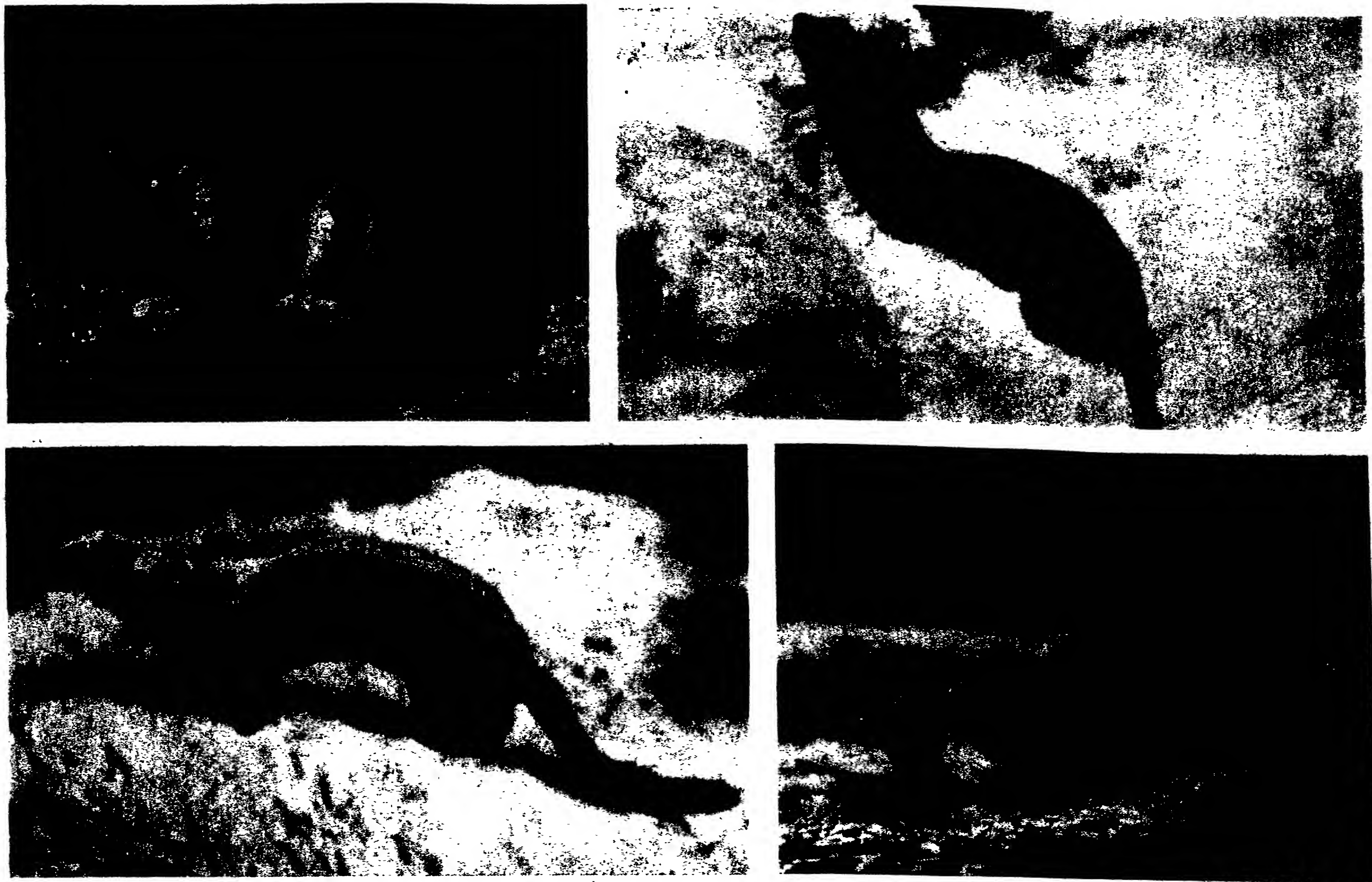
DINGO PUP AND TIMBER WOLF CUBS

About six or seven to the litter is the general rule for dingo pups, the offspring of the wild dog of Australia. They are frequently born in hollow trees. Young timber wolves, natives of North America, undergo a course of maternal care, being educated to catch their food and beware of danger.

THUS, from this brief survey, it will be seen how various is the childhood of animals, from the long adolescence of a young elephant under its mother's anxious care, or that of a young chimpanzee in its family circle, each having to gain experience of the world and learn how to make its way in life, to the brief upbringing of a little bird, with its considerable outfit of inherited instincts, but which, even in its short childhood has much to learn. The human child can certainly console himself, or herself, for long hours spent at lessons with the thought that every little creature has likewise to go to school: whether it be a young otter learning that toads are nasty, or a chick finding out that red thread is not good to eat. The speculative elder can mark the dress, behaviour and inherited aptitudes of young creatures and thereby learn something of the history of the race; though he must not forget that special adaptation plays its part among young as well as elders, for natural selection is a force that bears equally on all ages, and even upon the joyous play of the carefree and delightfully irresponsible young wild animal

The biological significance of play, as already hinted, is unquestionably preparation for later life, and the tuning up of the brain and muscle ready for the calls that will then be made upon them Hence it follows that play generally takes the form of mock combats, or mimic hunting, foreshadowing the later activities of the animal · yet in the young unsophisticated creature there is a certain element of joyousness, a bubbling over of vitality, which seem above and apart from such businesslike play

The whole question of this urge in adolescent animals to play is dealt with specifically in Chapter XVI entitled Playtime Among the Birds and Beasts which, with the present chapter, comprises an examination of an important phase of animal life. This phase is one which will go far to help us in the study of the wild children of Nature



STOAT AND WEASEL CUNNINGLY CLAD ACCORDING TO THE SEASON'S CHANGE

Both upper and lower photographs on the left are of the stoat and those on the right of the weasel. The former is slightly larger than its near relative, the weasel and, whether in its winter coat of white or in its dark summer fur, the tip of the tail is always black. In Scotland and the North of England the stoat turns white in winter, but this change becomes rarer as the more southern counties are reached. The animal is called the ermine when white. The weasel is the smallest and most ferocious, and also the most often seen of its race, and though small enough to invade the galleries of field-mice will attack a rabbit, which is far bigger than itself. In summer its coat is light yellowy brown with white underparts.

Chapter XXVII

Animals that Change their Clothes

By Dr. H. Graham Cannon

Professor of Zoology, Sheffield University

Clothes play a very important part in our lives. To be comfortable we must be properly clothed. If our clothes wear out we must buy new ones. If we grow out of them we must obtain a larger size. When winter comes we must put on our thicker garments and for each occasion there is an appropriate suit of clothing. Now, animals do not wear clothes, but, if we consider their skin, their shell or covering of feathers as their clothes, we shall see that a great many animals are capable of changing their clothes for different purposes and occasions, just as we are ourselves.

First comes the case where an animal's outer covering wears out. We are all familiar with the moulting of a dog. At certain seasons of the year the hairs become brittle and have to be replaced by new. Each hair grows out from a root at the bottom of a little pit in the skin. At the moulting season the hair ceases to grow, breaks off at its base inside the little pit and another new hair begins at once to grow out in its place. This pushes out the old hair, which then falls off The old hairs are thus pushed out by the newly-growing ones, just as our own milk teeth are forced out by our permanent second set. A very striking example of moulting can be seen in the wild sheep, which are to be found in any big zoo. The wool is thrown off in thick, tangled patches, and gives the animal a very untidy appearance until it has all been cast and the animal stands all handsome in a spotless new woollen suit.

In some cases the hairs, which grow after a moult are quite different from those that they replace. For instance, the fur of a young tapir is marked with brown and white stripes running the length of the body, but after a year of life it moults and puts on a totally different coloured coat, black fore and aft and greyish in between. There are many other cases of animals which are born in a suit of baby clothes but which later put on their grown-up suit.

Among birds, moulting is perhaps even more marked than among mammals. The feathers of a bird are made for very hard wear and tear, and it is not surprising that they have to be replaced periodically. Moulting is usually a slow process, so that meanwhile the bird is not put out of action, but in some cases, as, for instance, in certain geese, the feathers fall so rapidly that, for a time, the birds are unable to fly. Now, birds, in addition to feathers, are covered in certain places by scales, for example, the legs of a fowl. Claws are modified scales, and in the grouse these are moulted and replaced by new just as are the feathers. The bill of the puffin is partly covered by scales, and the outer parts of these are shed annually.

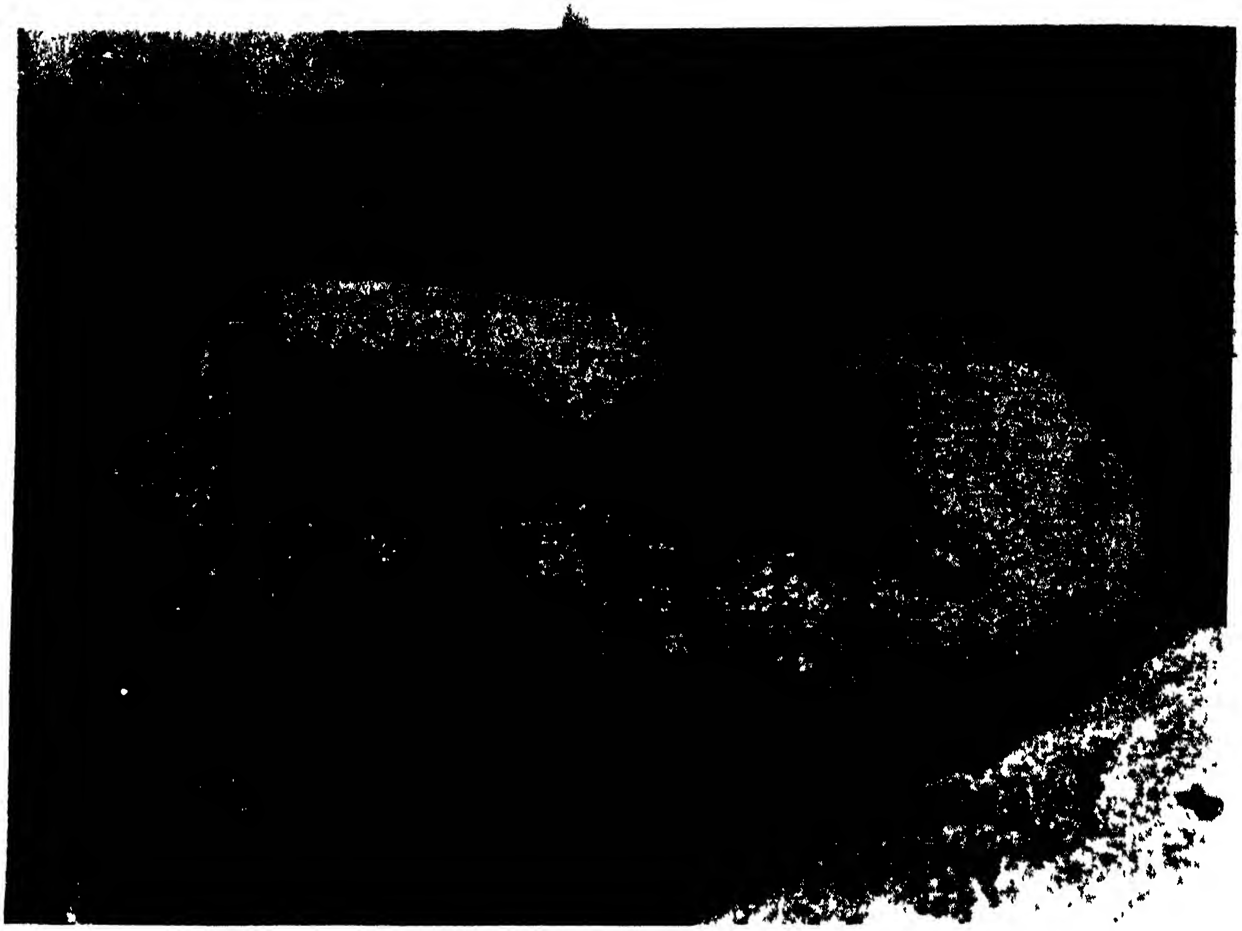
Up to now we have dealt with cases where the clothing wears out, but, more often than not, especially when we are young, we have to obtain new clothes because we have grown out of our old ones. This often happens in the animal world In newts and frogs, for example, the outer most layer of skin consists of a few layers of flattened cells which are not, in the strict sense, living. They are horny, and not very elastic, and, as a result the whole outer layer is cast periodically while the animal is in process of growing.

In the frog the skin usually splits down the back, while in the newt it splits round the mouth and the animal

F. W. Bond

BULL SNAKE AND ITS OLD SUIT

Every now and then snakes have to shed their skins, and this they do by rubbing themselves against tree trunks or stones, when the skin splits at the mouth and the snake glides out in a new skin, incidentally turning the old one inside out in the process



TWO SHELLS BUT ONLY ONE CRAB

Growing too big for one's clothes always causes a certain amount of trouble, and the crab goes through a critical time when it needs a new suit. The complete outer covering, legs as well as shell, is cast so that we get the crab, as here, and a complete but empty replica beside it. But the new shell is very soft and no protection, and so the crab must hide in some sheltered nook for a day or two while the new armour hardens. In the photograph the empty shell is on the left and the specimen is of the edible crab.

wriggles out of its "shirt." The cast skin of a newt may sometimes be seen in an aquarium looking like a transparent ghost, but usually both frogs and newts are economical, and eat the skins as soon as ever they are cast.

Snakes and lizards are covered with scales which are embedded in the skin. These are covered by a thin, transparent, horny layer which is shed or sloughed periodically, just as in the case of the newt. A difference must be noted here between this sloughing and the moulting of a bird. The scale of a lizard must be compared with a feather, in fact, some authorities consider that the bird's feather evolved from the reptilian scale. Now, in the case of a lizard, only the thin outer covering of the scale is shed while it is the whole feather that is cast at the time of a moult.

There is a very large group of animals called the Arthropoda, which includes all insects, spiders and crustacea—the shrimp and crab group. In these animals the whole outer covering has become hardened to form a rigid armour. In places it remains thin and flexible, so that the body and limbs can be moved by the muscles which are attached to its inner surface. In fact, the arthropoda can be considered as animals whose skeletons are on their outsides instead of deeply embedded in the body, as in us. The basis of this external skeleton is a substance called chitin, and it is produced or secreted by the actual skin, which lies immediately inside it. Except at the thin joints of the body it is often reinforced by salts of lime.

Now, in the case of these animals gradual growth as in a mammal or bird is obviously impossible. The result is that the life of, say, a crab, is simply a succession of moults, the crab in between the moults growing too large for its own shell. Between the moults the tissues of the body tend to increase in bulk, but cannot owing to the rigid shell, until at last the latter bursts and the body inside escapes clothed only in its real, thin, flexible skin. It immediately swells and begins to lay down once again on the outside of its skin the reinforcement of chalky chitin. The growth of an arthropod can thus be compared to walking up a flight of steps while the growth of a mammal is a process which rather resembles walking up a gradual slope.

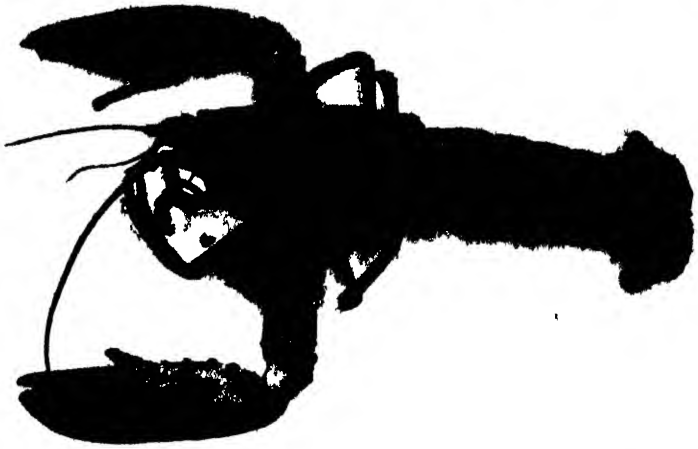
Immediately after moulting, the arthropod, especially a form with such a hard skeleton as a crab, is a very helpless creature. It has not only lost its protecting armour but has lost the rigid support for its muscles. It is not surprising then, that when a crab is about to moult, it discreetly retires into some narrow crevice where it is hidden from its enemies. These "soft" crabs are much sought after for bait, and can often be found under rocks sitting by the side of their cast-off suit, now too small.

In many of the arthropoda the young forms or larvae are totally different in appearance from the adult. For instance, the barnacle, which is found on rocks all round our coasts, is a small, limpet-shaped crustacean. It remains fixed throughout its adult life to the stone. Its larvae, however, are quite different. The egg of the barnacle hatches as a minute triangular larva called the nauplius, which swims about in the sea. After several moults, during which it increases in size but retains the characteristic triangular shape, it throws off its naupliar shell and emerges as a totally different shaped larva, the cypris larva, which looks like a minute mussel. It is a bivalve, that is, it has a pair of shells which fit together and enclose the rest of the body and limbs This now comes back from the sea with the incoming tide and settles down by its front pair of legs on the rocks. Here the larvae remain for a while and can be seen high and dry between tide-marks scattered over the rocks as little oval, glistening bags among the older barnacles When the tide comes up again the larva finally moults, throwing off its bivalve shell and emerging as a minute but perfect adult barnacle, condemned for the rest of its life to sit on the same piece of rock.

Now in these cases, when the nauplius changes to the cypris, or the cypris to the adult, the hard external shell serves as something more than mere clothing to the body. It serves as a box inside which the whole body can be reorganized. The cypris larva immediately after it has moulted from its previous naupliar stage fits its new outer chitinous covering as a hand fits a glove, but, once this shell has hardened the real cypris larva inside proceeds to reorganize itself into the form of the adult. Thus, if a cypris larva which has already settled down on the rocks is examined by means of microscopic sections it is found that inside the cypris shell there is folded up in a most complicated manner a perfect adult.

Many such stories could be told. The crab, for instance, goes through a similar series of changes of shape during its growth from egg to adult. The butterfly, another arthropod, is a very familiar example, but this case is somewhat different from the barnacle story. The egg of the butterfly hatches and the young caterpillar grows to its full size by a series of moults. It increases in size at each moult but does not perceptibly alter its shape. It then pupates, that is, it contracts, its skin hardens and it goes into an inactive resting stage called the chrysalis or pupa. Now, inside the pupal case a complete rebuilding of tissues takes place and the butterfly is formed, beautifully folded up, and finally after some time it emerges as the adult insect. In this case the change of body form is so great that the larva has to go into

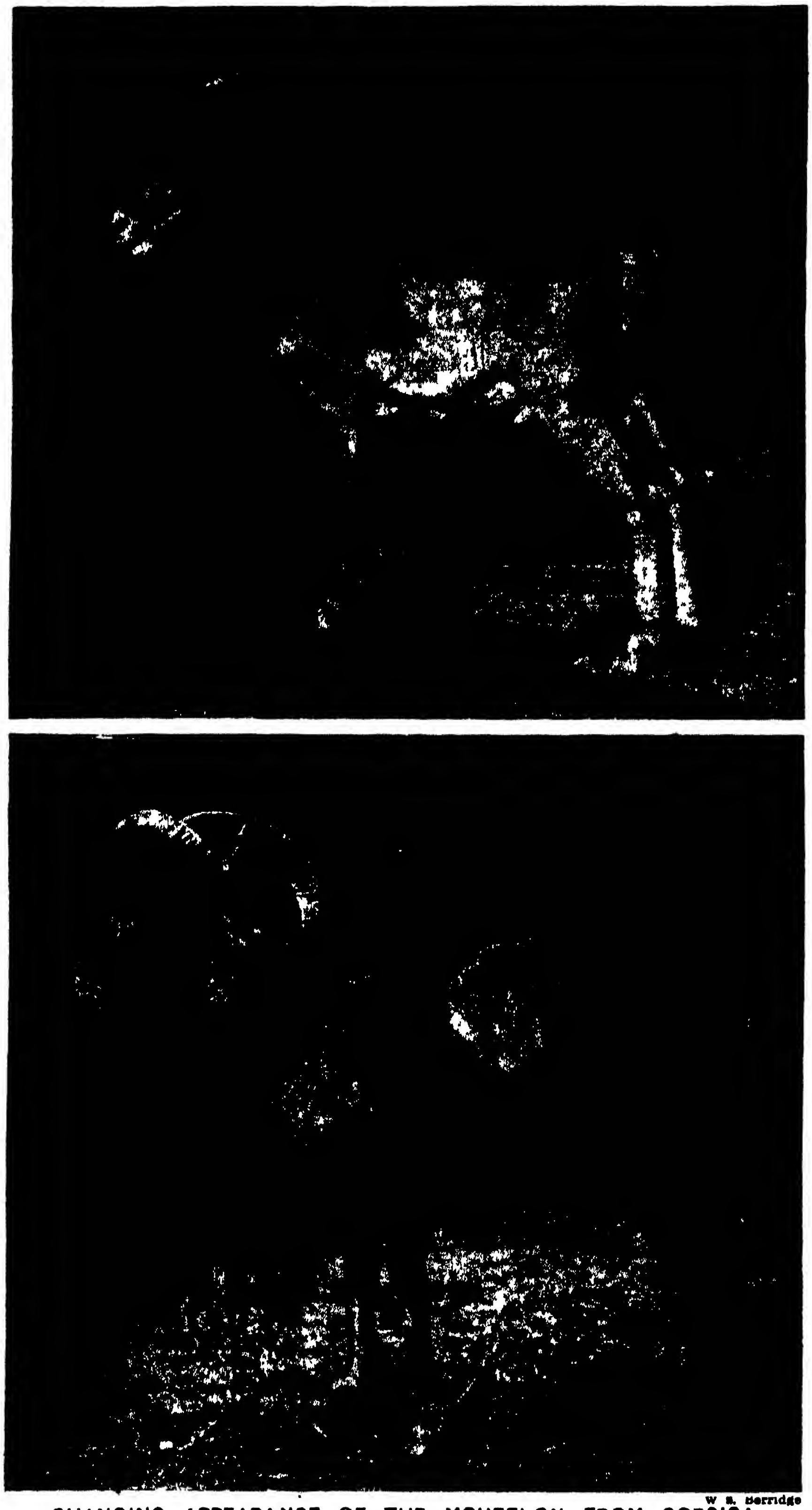
Neville Kingston



F Martin Duncan

HOW THE LOBSTER DISCARDS ITS OLD CLOTHES

Lobsters have to shed their tough armour plates just as crabs do. Such rigid coverings do not allow for more than a limited amount of growth. Our bottom photograph shows, not a lobster but the deserted shell of one as it was found one day on the floor of one of the tanks in the Aquarium at the London Zoological Gardens. Above is the lobster itself.



W. S. Berridge

CHANGING APPEARANCE OF THE MOUFFLON FROM CORSICA

This species of wild sheep is found only in the Mediterranean islands of Corsica and Sardinia. It lives in flocks in the very highest parts of the hills and is very timid. The winter coat (bottom) includes heavy festoons of hair on the chest, while in the summer a change suitable not only to the climate but the altered light conditions is made (top)

a resting stage in order to carry out the necessary alterations. It is like a ship going into dry dock for refitting. The machinery must be altered from the crawling mechanism of the caterpillar to the flying machine of the butterfly, and so the clothing of armour is used as a box in which the transformation can be carried out undisturbed.

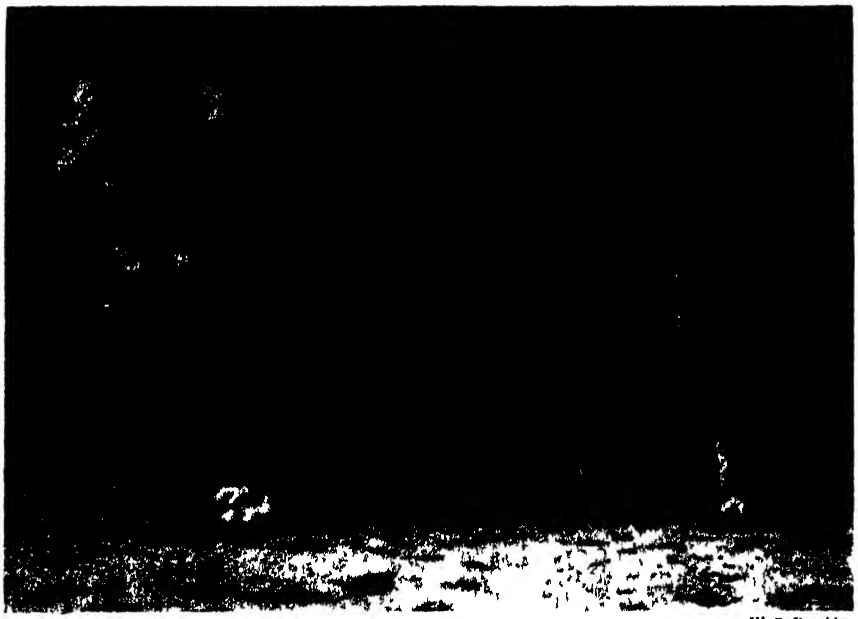
But these are not the only reasons for the persistent moulting of the arthropod. Chitin, which, as we have already seen, forms the basis of the shell, is a complex compound of ammonia. Now substances distantly related to ammonia are being continually produced in the animal body as waste products resulting from its activity and, by some means or other, they must be thrown out or excreted from the body. The arthropod is an economical animal and uses them to assist in the production of its chitin. Moulting of an arthropod is one of its methods of excretion.

We have now considered cases of animals which change their clothes either because they have worn out or because they have become too small. It constantly happens that in some animals and birds the time taken for the clothes to wear out agrees closely with the seasons. A new coat grown in the spring is ready to be cast off at the beginning of the next winter. In these cases the winter coat may differ from the summer coat and, in fact, may be particularly suited to the cold snowy months of winter. Thus the stoat, which is brown in summer, sheds its coat for a pure white suit at the onset of winter. The mountain hare behaves in a similar manner. Strangely enough, in both these animals one small part of the body remains the same colour throughout winter and summer. In the stoat the tip of the tail and in the hare the tips of the ears remain black.

This seasonal change is not confined to mammals. It is

Animals That Change Their Clothes

shown in many birds. The ptarmigan moults three times a year. During the summer it is brownish like the grouse, in the autumn it moults and develops a greyish plumage, while in the winter it turns white. This winter whiteness is obviously of use to the animal in making it inconspicuous against a background of snow, but the value of this camouflage must not be overrated. The country in which these animals occur is not always or completely covered with snow during the winter months and a white hare standing out on a ploughed field is as conspicuous as any animal can be. There is, however, another value in the white winter coat. Mammals and birds are warm blooded creatures, that is, their body temperature is higher than that of the surrounding air and is maintained practically constant throughout the year. Hence they always tend to lose heat into the surrounding atmosphere and, as this heat is lost, so more heat has to be generated from the food inside the body. Now a hot body loses heat much faster in a cold room than in a hot one. A kettle of hot water will cool much more quickly in an ice chest than in a hothouse. Hence mammals tend to lose heat more rapidly in the cold winter months than in the summer. A white object loses heat by radiation less rapidly than one of any other colour. Hence the value of the white coat is that it minimises the loss of heat by radiation and so efficiently economises the natural fuel of the body.



W. S. Berridge

ARCTIC FOX READY FOR SUMMER AND WINTER WEATHER

Common all over the Artic regions is the small Arctic fox, which in the summer time (bottom) is black. In size it is inferior to the Common fox. The fur is exceptionally soft and thick, and when the winter arrives the whole coat turns white (top) and an extra coat of shorter fur is grown underneath. In the spring this under-fur comes off in patches.

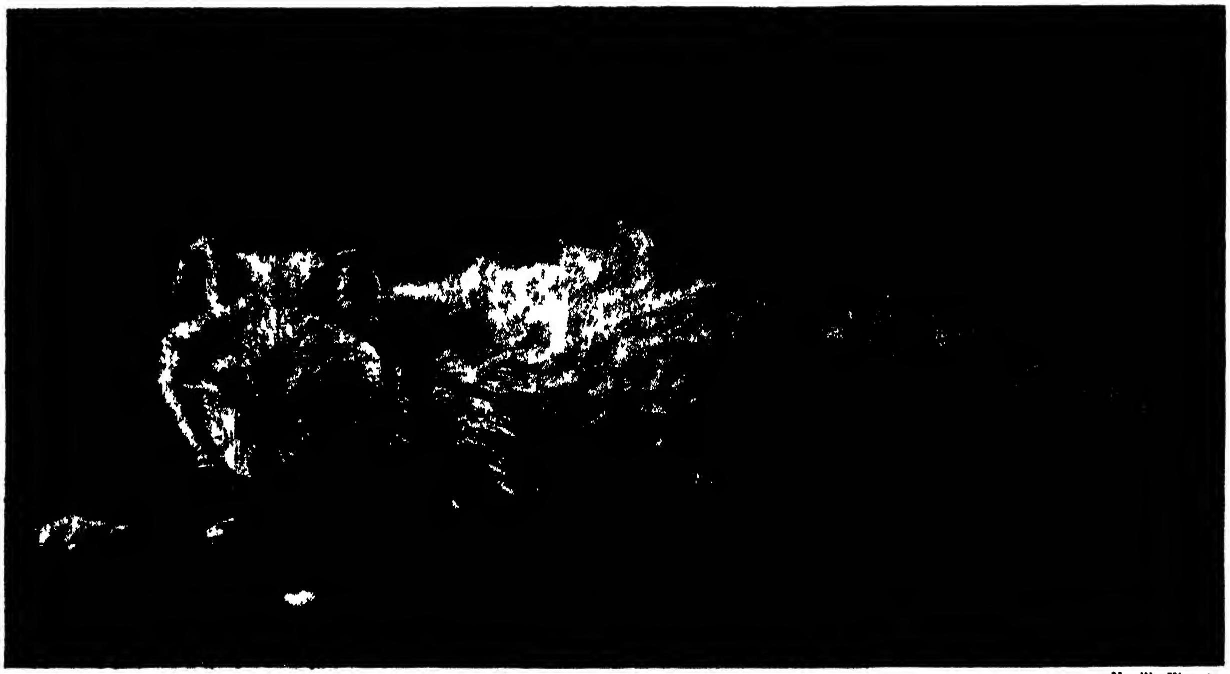
Now while the protective value of these white winter coats from the point of view of camouflage may be questionable, there are many animals which have a remarkable power of adjusting their colour and general appearance to fit in with their surroundings. That is, they do not actually change their clothes but appear to do so.

Perhaps the most popular example is the African reptile the chameleon. The marvellous way in which this creature can change its colour to harmonise with the foliage on which it is crawling is so well known that it has even given rise to fable in the story of the unfortunate chameleon which, when placed on a Scotch plaid either died or burst but accounts differ. A better example, however, one which we can see in our own countryside, is the common frog. Whether it be found sitting at the bottom of a pond or hiding under the shelter of a rock it has usually managed to regulate its hue to resemble very closely the general tone of its surroundings. The common flatfish, the flounder, is another very good example; in fact, it is extremely difficult to make out a flounder lying quite still on a gravelly bottom. It is so expert that it can regulate its own mottling to

fit in with the coarseness of the gravel or sand on which it is lying. If it is placed on a pure white background it will become very pale. If now, it is placed on a black background it darkens immediately. On a white background covered with black spots, provided the spots are not too large it even makes a fair attempt to copy the background

How are these changes brought about? The colour of both frogs and fish is due to the presence in the skin of a large number of mobile cells containing pigment granules. The cells can expand or contract, can press nearer the surface or retract from it. The pigment may be black or red, yellow, or of an opaque whitish reflecting nature, and all the colour changes are brought about simply by the re-arrangement of these pigment-bearing cells. When the animal darkens the black cells expand or come nearer the surface and conversely retract when the animal blushes paler. In the case of the fish, there is certain evidence that the pigment cells are each controlled by a minute nerve, although this may not be the only control. Thus in a turbot in which a big nerve in the head region had been severed, the skin round the jaws supplied by that nerve remained permanently dark when the fish was placed on a white background. The severing of the nerve cut off the pigment cells from the stimuli which normally passed down that nerve from the brain, and hence no message reached them when the background was changed.

W S Berridge



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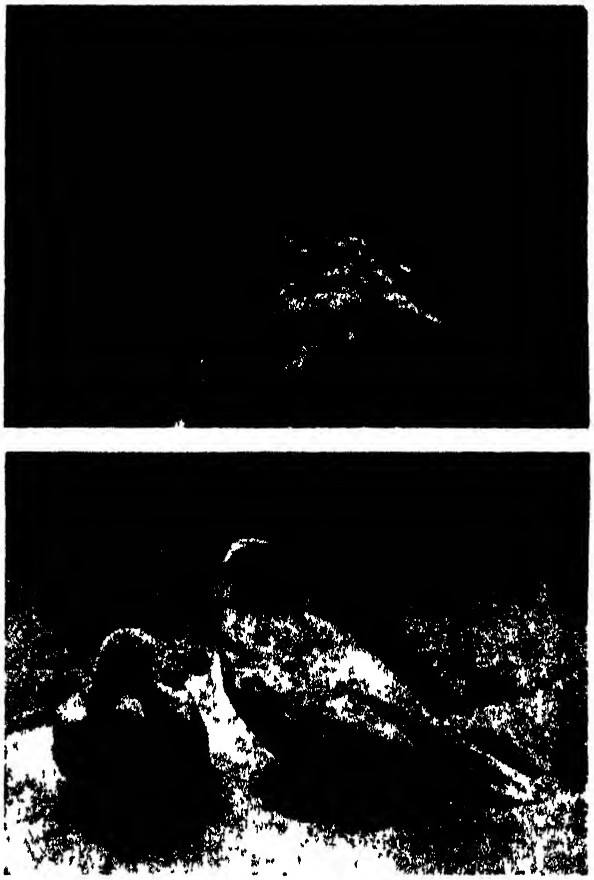
HANDSOME ANIMALS GROWN UNSIGHTLY WHEN CHANGING THEIR CLOTHES

When the musk ox (top), which is found in the extreme north of Canada and Alaska, moults it presents a very sorry appearance with its old coat hanging in wretched tatters above the new spring suit Similarly, when the Arctic fox (bottom) is in the transition stage between warm and cold outfits a once graceful animal looks really dejected The new coat, dark grey to black, can be seen on the hind quarters, where the winter coat of white has quite gone. But the rest of the animal is still in the half-and-half stage

What causes the stimuli to leave the brain ? This finds an answer in the fact that a blinded fish shows no colour change. The chain of events seems to be that the background is reflected in the eye. This sends a message to the brain and, from this centre, appropriate messages are relayed through certain nerves direct to the pigment cells and bring about the colour adaptation. It must not be thought that this is the complete story ; there are, undoubtedly, other ways in which the extraordinary colour responses may be brought about.

In the frog there is no definite evidence that the pigment cells are under a direct nervous control ; in fact, experimental evidence suggests the reverse The controlling mechanism here seems to be primarily through what is termed an ' internal secretion.' An internal secretion is a substance produced in one part of the body and carried by the blood stream to other parts where it produces some definite effect. Thus the thyroid gland produces a substance which affects growth in all parts of the body. There is another small gland called the pituitary body, which is situated at the base of the brain. In mammals the internal secretion of this gland also regulates growth, especially that of bones, but in the frog this same secretion is an important factor in the control of colour response. By a very delicate technique it is possible to remove the pituitary rudiment from a tadpole. An individual so treated remains permanently pale, but on injection of an extract of pituitary body it becomes at once much darker. The effect wears off after a time and the experiment can be repeated. An interesting point is that this effect can be produced whether the extract be obtained from the pituitary of a frog, a mammal, a bird or a fish



W. S. Berridge

WILLOW GROUSE, WINTER AND SUMMER

This bird is the European, Asiatic and North American representative of the red grouse which is found only in Great Britain The willow grouse changes its plumage in winter, when it is dove-white (bottom) In between the changes it is mottled (top)

ANOTHER group of animals showing very marked colour changes is the Crustacea. There is a very beautiful prawn called hippolyte which swims about among seaweeds and it is found that those caught above brown weeds are always reddish brown, while those from green weeds are bluish green Further, if the green forms are kept in an aquarium with the brown weed they adjust their colour accordingly, usually at once. At night, fishing over the same weeds, all the prawns would be found to be a beautiful transparent blue. There is thus a daily change : during the day the prawns match their surroundings, but at dusk they put on their night clothes. The colour cells of a Crustacean are more complicated than those of a frog ; they may contain pigment granules of more than one colour so that the same pigment cell, by spreading out within itself one set of granules and retracting another, may at one time appear, say, yellow, and at another, red. Further, these cells appear to be affected directly by the light falling on them. Thus, in a blinded prawn or in isolated pieces freshly cut from a prawn, the colour change is still obtained. However, if the prawns are kept continuously in a bright light they still show, to a certain extent, their normal nocturnal transparency. Thus, in addition to the direct effect of the light, there must be some daily rhythm in the animal or in the pigment cell itself which causes it daily to expand and nightly to contract

There are other animals which can very rapidly change their appearance but in which the colour change may not be of any value as a camouflage. The octopus, for instance, if disturbed in an aquarium, may blush immediately a deep purple brown and then, as suddenly, lose its colour. It is difficult to say what is the value, if any, of this emotional colour change, but we must not forget that, before we can say that this is not some sort of camouflage, we must place ourselves in the position of the enemy or the prey of the octopus, and try and visualise what such a sudden change would look like when viewed underwater from the rocks among which the octopus lives.

In India there is a group of chameleon-like lizards called *Calotes* which show a very marked emotional colour change when fighting or courting. The male, when courting the female, develops a conspicuous dark patch on either cheek, but when he is driven off and captured the black spots are found to have disappeared. This case should not appear so strange to us when we remember that some of us may blush

W S Berridge

FINDING NEW CLOTHES INSTEAD OF GROWING THEM

Since the hermit-crab is not protected on its hinder portions by a shell, it finds one deserted by its original owner and uses that As it grows, successive shells are discarded for larger ones Here are (bottom) a hermit-crab in a whelk shell and (top) a crab which has left one shell and is seeking another. During the transition stage the crab, whose body is very soft is in a perilously undefended state

furiously, or, maybe, go deadly white, when engaged in an exactly similar occupation.

These emotional colour changes lead on to those marvellous cases of breeding display found among birds In many birds, the male, at breeding season, moults and develops a special breeding suit of feathers, and in this new garb attempts to attract the hen bird. But he is not content with merely a change of clothes. He parades and dances and strikes all sorts of grotesque attitudes so that, like a quick-change artist, by continually putting on new garbs he flatters and entices the female audience. The peacock, with its gorgeous tail spread and its head thrown back, appears a different bird from the graceful cock walking sedately. The cock bustard, at the height of its display, is hardly recognizable as a bird. Every feather seems to be turned over into the middle of its back, its throat is distended to an enormous bag, and its head is lost in the pillow of feathers on its back. The argus pheasant spreads out its wings and brings its tail forward so that together they form one broad sheet of beautiful feathers, but the bird's head and neck seem to have disappeared completely. Actually, the head is thrust back underneath and behind one of the wings, and the cock keeps one eye on the hen, staring through a minute gap left between the wing and the side of the body.

These gorgeous displays are not, however, always harmless parades in front of the hens. In the case of the black grouse the males gather together and combine their displays with actual fights in front of the usually uninterested hens. And this brings us finally to the cases of animals which put on special clothes for fighting purposes In the ordinary deer, the male grows its magnificent antlers, and their only real use seems to be for fighting. At breeding seasons the males become very aggressive and fight each other, using the lower branches of the antlers to stab at their rivals. It must be admitted, however, that they are not very efficient weapons, and the hoofs seem to be much more effective. Each year the antlers grow anew and each year an extra branch or tine is added. Towards the end of the year the blood supply at the base of the antlers becomes cut off, with the result that this region becomes brittle and the whole antlers break off at the base.

At the outset we enumerated a few of the reasons why we change or obtain new clothes. From the cases we have so briefly considered it is evident that we are not supreme in our sartorial efforts. What is to some of us a matter of grave importance and, to most of us, of great expense, is to the other animals part of their everyday life. They may be provided annually with one, two or even more suits, or they may possess a coat which outrivals the wardrobe of the most expert quick-change artist. With them their clothing is part of themselves, a legacy from their ancestors.

This legacy benefits different animals in different ways One changes its clothes because it needs to harmonise with its surroundings for the avoiding of hungry enemies; another because it has grown too big for its old suit, and yet another for the purpose of adapting its natural covering to the seasonal variations of the weather or to the needs of courtship. Each of these changes is a marvel, both in purpose and in method, of the wonderful animal world

F. Schensky

COMPASS MEDUSA DELICATELY UNDULATES THROUGH THE SUMMER SEA

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Chapter XXVIII

The Wonder of the Seashore

By Mrs. E. W. Sexton

The Marine Biological Laboratory, Plymouth

THE seashore—where the earth and ocean meet—the very name is a magic casement opening on a wonderland of life and beauty.

Life is the most striking character of the shore. Nowhere else in the whole world is it to be found in such infinite variety and such amazing profusion as on this narrow strip of land between tide marks, and yet nowhere else are the conditions so complex and the problems of existence so acute.

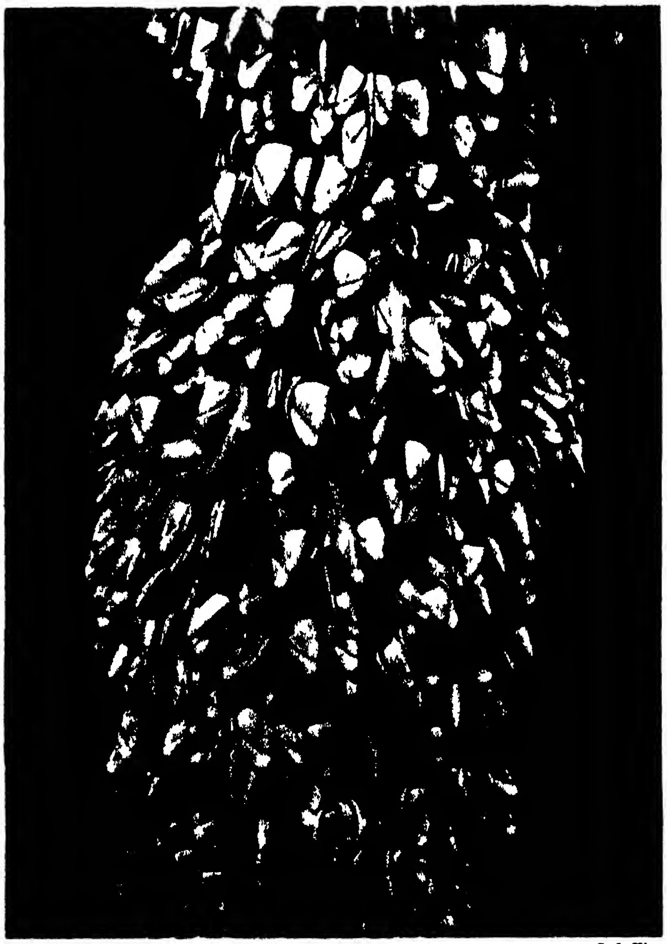
Take any typical shore animal, such, for instance, as a sponge which is fixed to the rock, or a sea anemone capable only of limited movement, or even a shore crab able to move about on the beach, and innumerable questions spring up. How is it possible for them to endure daily the twice recurring ebb and flow of the tide, the exposure to the sun, wind, dust or frost, followed by complete submersion? Land animals breathe dry air, sea animals breathe air dissolved in water, but the shore population has to spend half its time on land and half in the sea. What kind of breathing apparatus can such creatures have?

How can they guard themselves against wave shock? Sometimes the tide "comes silent flooding in," but what about the gales when the waves break in thunder and hurl huge boulders on the shore and against the cliffs? How can any living thing escape then?

And again, how can they protect themselves from questing enemies, the birds which hunt on the shore when the tide is out, and the voracious fishes when the tide is in? Then the question of food: how can stationary animals get it, and how can they propagate their kind and ensure a start in life for their young? There is no end to the problems, and the more we explore them the more wonders are revealed.

We have in the United Kingdom, compared with the total area, a coastline of great length, about 7,906 miles. The tidal zone alone—that is, the part lying between high and low water marks—has been estimated at 620,000 acres. As on the land so in the sea, the life of the animal is primarily dependent on plant life. The food of the fishes is really, though indirectly, derived from the floating "sea meadows," immense fields consisting of untold millions of microscopic plants drifted along by the winds and currents near the surface of the sea. And on the shore, wherever a foothold can be found, are the fixed seaweeds, each type of shore with its own particular community of plants, and each community with its associated animals seeking food and shelter. The vegetable feeders, like limpets and periwinkles, live directly on the weeds, and the predatory animals follow to feed on the vegetarians. It is the same in the sea meadows—where incredible numbers of tiny animals, copepods, little crabs, jellyfishes, baby sponges, newly-hatched fishes, swim and feed among the plants; following these come the bigger fishes, and then the birds, taking toll of all on the shore and in the sea. The microscopic floating life of the sea is known as plankton, from a Greek word meaning 'that which is drifted.'

Following the tide down from high water mark to the water's edge it is interesting to note the different series or "zones" of plants and associated



C. J. King

BARNACLES CAST UP BY THE TIDE

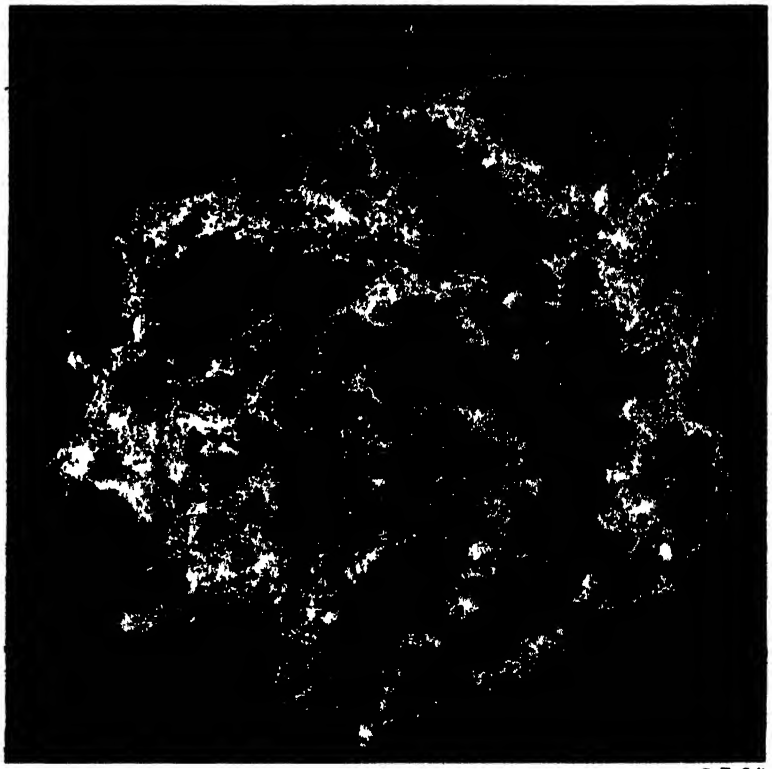
Attaching itself by a long fleshy stalk to any driftwood it can find the barnacle feeds by protruding certain feathery feelers and drawing in the minute organisms with which the sea is filled. In old days sailing ships were much handicapped by the thousands of barnacles on their bottoms

regions—sponges, sea firs, anemones, corals, starfishes, bristleworms, crabs, prawns, shore fishes—all different in structure, habits, weapons and ways, but alike in having life histories so varied and amazing as to read like fairy-tales. It seems incredible, for instance, to find a microscopic swimming animal about the size of a pin's head, settling down and starting a colony, and a colony, moreover, in which division of labour is carried to a remarkable extent, with different members allotted to different duties. Yet this is what the tiny hedgehog hydroid (*Hydractinia*) does. Its colonies are usually made on shells inhabited by a hermit crab and with a lens, the individual polyps can be watched at work; some are employed in catching the food and distributing it to the colony; some, much smaller, produce and carry the eggs; while others around the margin guard the whole, coiling and uncoiling and lashing to and fro when touched.

Again, who would expect to find a mutual benefit association between creatures so diverse as a crab, a worm and an anemone, to give one instance?

animals that we meet. First, on the highest part of the beach, only reached by spring tides and spray, the channelled wrack (*Pelvetia*) is the predominating seaweed. Here most of the inhabitants, limpets, periwinkles, dogwinkles and acorn barnacles, are protected by heavy solid shells and wonderful devices for shutting themselves in and keeping moist till the tide returns. The limpet, for example, makes a pit or "scar" in the rock, the exact size of its shell, and settles tightly into it; the periwinkle has a little shutter or lid with which it closes the entrance to its home, while the acorn barnacle builds a hinged roof to its house and shuts it as the tide ebbs

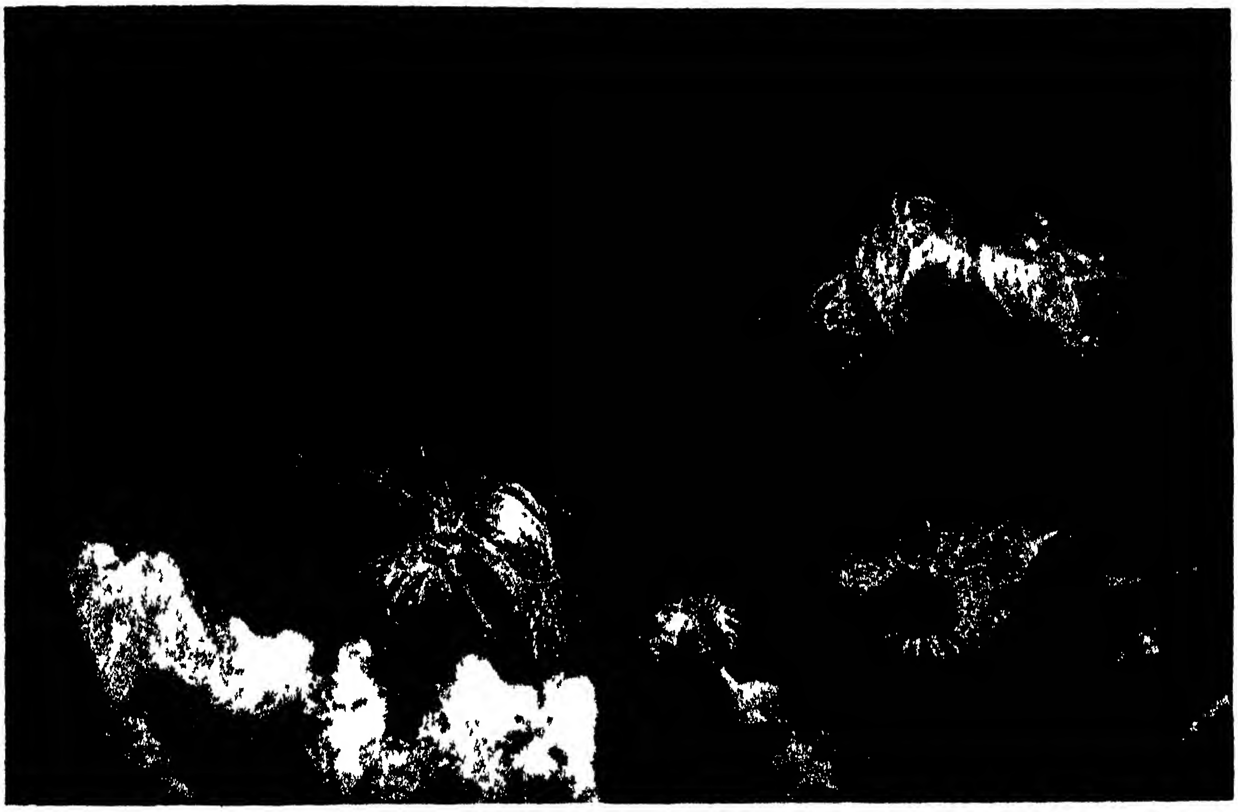
Lower down the shore many varieties of seaweed flourish, but the prevailing types are the *Fucaceae*, such as the flatwrack; bladderwrack, with numbers of round air bladders in pairs on the fronds, knobbed-wrack, paler and with larger bladders, and notched wrack. This "fucus zone" merges into the oarweed or laminaria zone, which is only uncovered during low spring tides. The name of tangles is often applied to laminaria. A vast number of settlers inhabit these



C F Gill

FOUND AT LOW TIDE: HYDROIDS & CRUMB-OF-BREAD SPONGE

On rocky shores we may discover a substance looking something like buff-coloured bread. This is the crumb-of-bread sponge which is a colony of minute creatures living and getting their food in this their wonderfully made commonwealth. The hydroids (bottom) also live in a colony which we may find attached to some seaweed.



Schensky

SEA ANEMONES, LOVELY FLOWERS OF THE SEASHORE, BLOOMING UNDER WATER

It is lucky for the observer that the sea anemone prefers to live in clear water fastened to hard, insoluble rock, because in these conditions its beautiful form and colour are seen to the very best advantage. Between high and low water marks, upon a shore which is covered with rocks, many of the loveliest varieties are to be found in the pools, growing like brilliant flowers in a submarine rock garden We have a particularly beautiful form in the thick-horned anemone (bottom), while the upper photograph shows the widowed anemone

Schensky

CURIOUS SEA CUCUMBER THAT DISCARDS PART OF ITSELF WHEN FOOD IS SCARCE

Among the rocks along the south coast of England lurks the sea cucumber, and it may be discovered when the tide is low. Its appearance is as deceptive as its name, for although it looks like a sea plant it is really allied to the sea urchin. It has a soft body, which it contracts and expands to move itself about, and about the mouth are ten branches, or stalks, ending in leafy-looking appendages. From the body protrude a number of sucker feet. The sea cucumber is remarkably adaptable to circumstances, for if it encounters a food shortage it very readily parts with portions of itself—the stalks about its mouth, the mouth itself, and even the intestines—only to replace them when times are better again.

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SEA ANEMONES GROWING AS THOUGH IN A SUBMARINE ROCK GARDEN

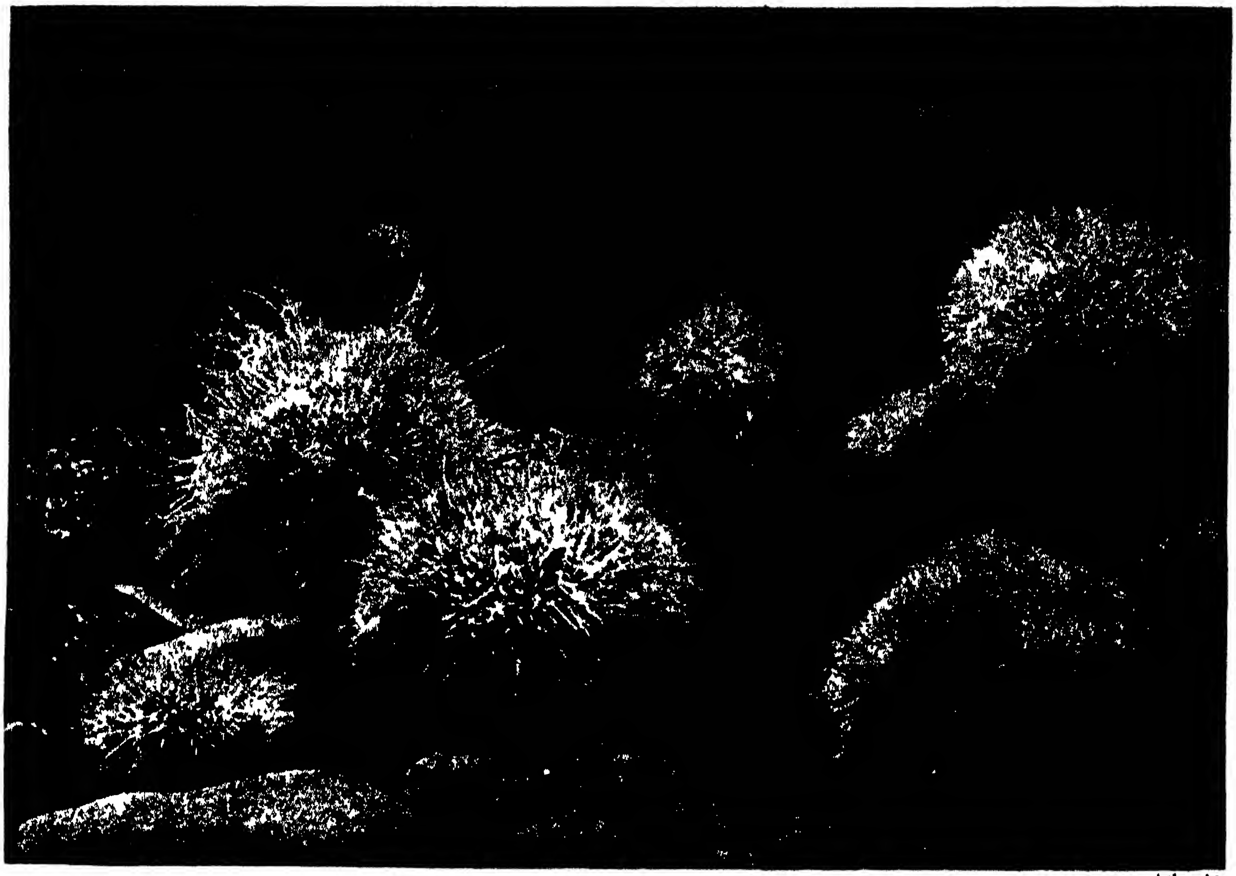
Among the crevices of rocks, especially along the coasts of Dorset, Devonshire and Cornwall, this beautiful anemone, the sea-pink, may be found clinging a short way above the low water mark. It has a way of flattening itself against the background so that it much resembles merely a soft incrustation of the rock to which it is fixed. The colour varies from salmon pink to orange brown, and perfectly white specimens also occur. Its tall stalk or body and its many short and delicate tentacles give it the appearance of some strange flower in a rock garden

The hermit crab lives in an empty whelk shell, with a worm tenant inside and a big stinging anemone outside. The crab's gain in the partnership is evident. It is a dainty morsel for a fish, but with the anemone prepared to shoot out masses of long, stinging threads on the slightest provocation it would take a braver enemy than a fish to risk an attack. The anemone and the worm profit by sharing the crab's meals, the worm gliding down the big claw and helping itself as the crab tears up the food, while the anemone bends down and collects its food behind the crab.

And then—to take another "fairy-tale"—what of the extraordinary method called "alternation of generations" employed by some of the stationary animals, by means of which they spread their young and give them a better chance in a new district? One of the hydroids (*Syncoryne*) lives fixed on rocks and seaweeds, and produces buds in the form of tiny jellyfishes or swimming bells, which swim up to the surface of the sea, there to be carried away by waves and currents, sometimes to a considerable distance before they scatter their eggs. The young which hatch from the eggs soon go down to settle on the bottom and develop into the fixed, tree-like hydroid again. And so the alternation continues, one generation, fixed, gives rise to the swimming bells, the next, swimming, produces the fixed again.

THIS same method can be seen in a small bristle-worm (*Procerastea*) living with the syncoryne, or rather, at the syncoryne's expense. The worm looks like an inch of yellow sewing cotton, but although so small, it has fifty to sixty segments in its body, and a head with long feelers, four red eyes and a sharp proboscis. It makes a thin transparent tube on the stem of the hydroid just behind a polyp, and there lies quietly until the polyp has fed, then as soon as a good meal has been collected, it darts out its proboscis and pumps away the whole of the food, leaving an empty, hungry polyp to collect a fresh supply for itself.

Procerastea multiplies in several ways. The parent worm may develop a "bud," which will eventually grow into a complete worm with long swimming bristles, very different in appearance from the parent. The bud breaks away when mature



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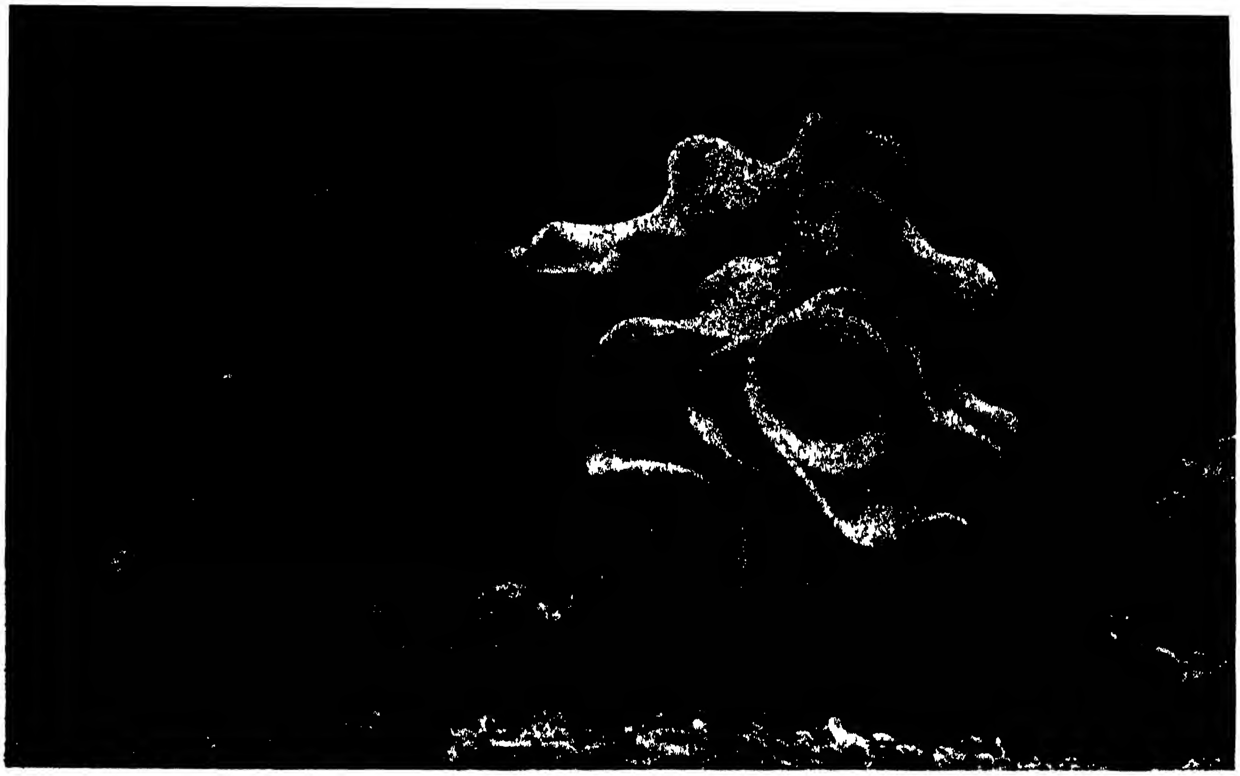
SEA-URCHIN, ONE OF NATURE'S MARVELS OF CONSTRUCTION

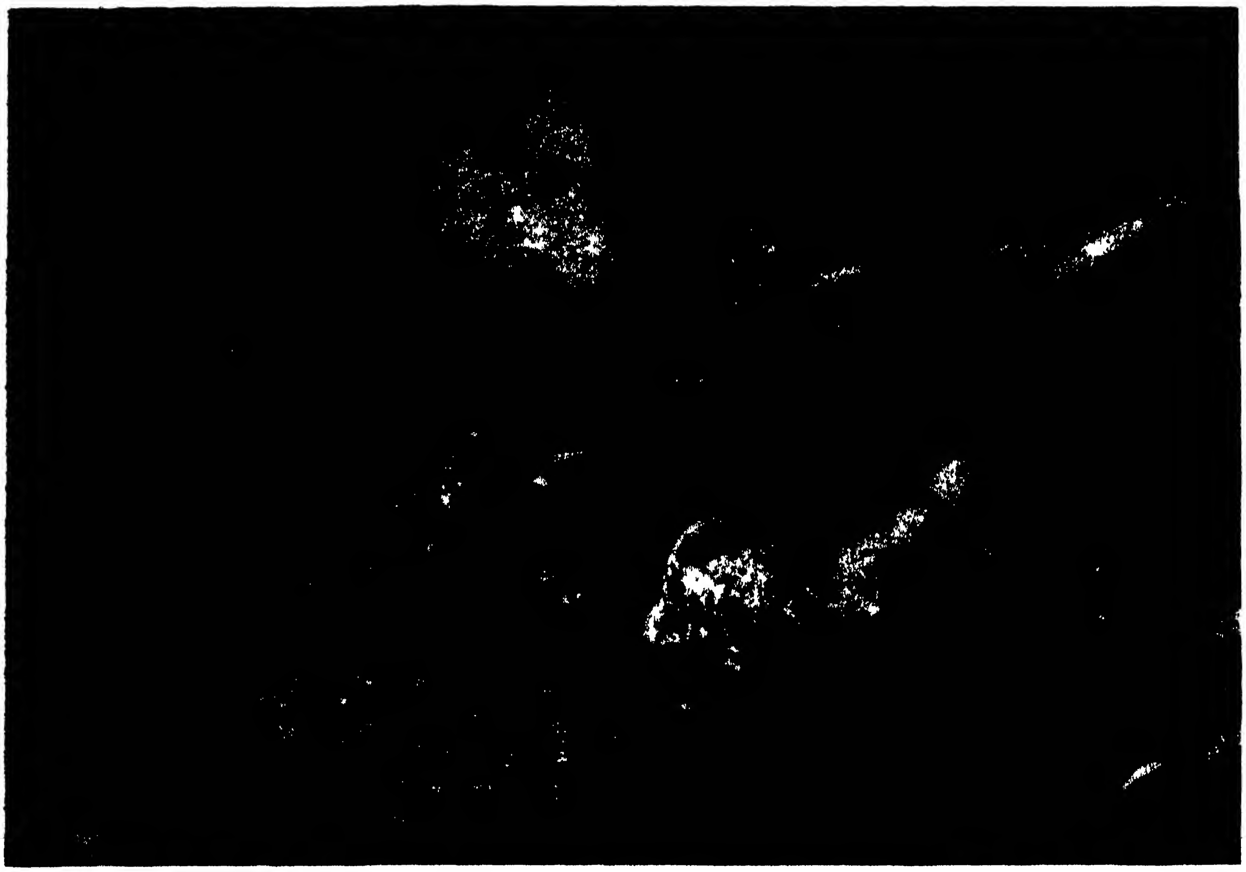
The shell of the sea-urchin is wonderfully made, being built up of a number of interlocked plates which are protected by spines, so that the shell has rather the appearance of a hedgehog. The sea-urchin moves along the sea bottom, mouth downwards, by means of its spines, which it can move, or by a number of tubes, like those seen on the underside of a starfish, which protrude between the spines. In some large specimens which may measure twelve inches round, there are nearly 5,000 spines The mouth is furnished with five teeth.

and swims up to the surface, where the eggs are scattered and the young hatched. These sink down to the bottom and grow like the first generation.

BUT procerastea has another and much more remarkable way of reproducing itself. It can break itself up into fragments, and then grow new heads and new tails to all the pieces! A similar process of regeneration can be seen in many of the larger shore animals. Anemones sometimes tear at the base as they move over rocks, and these torn pieces grow into complete anemones again. Starfishes are able, in a difficulty, to throw off one or more of their arms, and then grow new ones to replace them. The "comet" starfish is only a common starfish which has lost or thrown off four of its arms, and left itself with one long arm and the disc. A brittle star can break into fragments, leaving only the disc, and even then can grow afresh. Crabs and lobsters, too, are often found with one or both of the big claws missing, either broken in one of their frequent battles, or injured and thrown off by the animals themselves. At the time of the next moult, a new limb is grown

We cannot go very far on the beach without meeting the ubiquitous sponges, encrusting and sometimes eating away the rocks, and growing everywhere, even on crabs and oysters. Sponges are very low down in the scale of life, and look so much like vegetable growths that they were not recognized as animals for a long time. They begin life as tiny, free-swimming larvae, but soon settle down and start growing colonies. Each individual is shaped like a hollow vase with a large hole at the top, and numerous small holes or pores round the sides. Through these pores a current of water enters, bringing food, and air to breathe and flowing out again by way of the large hole. A remarkable arrangement of cells in the body of the sponge generates and maintains this current, each cell having a fine whiplash hair which keeps up a constant beating in the direction of the outgoing stream. The velocity of this current in some species has been recorded as two or three inches a second. The movement can be easily seen on putting a piece of living sponge in a dish of sea water and dropping a little powdered chalk over one of the holes in this unexpectedly energetic organism





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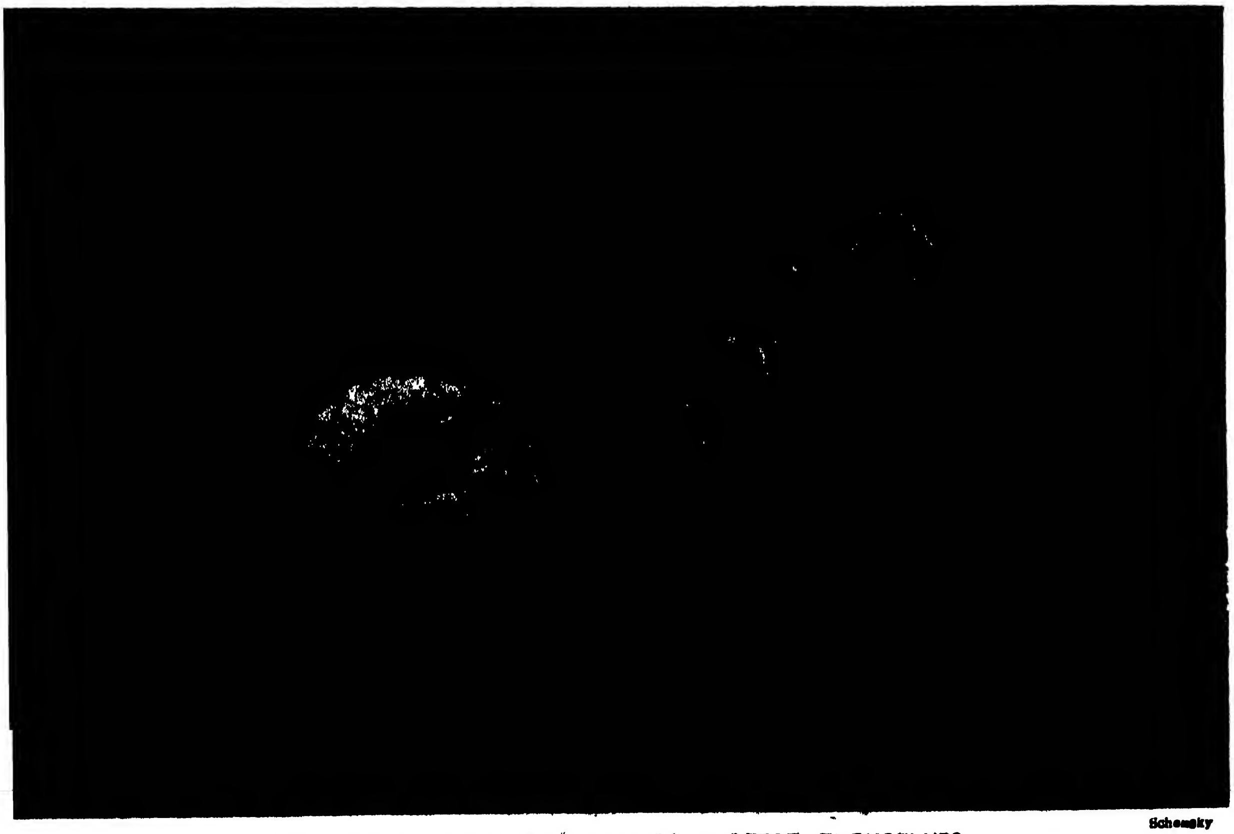
BED OF OYSTERS AND THE STRANGE WARTY SNAIL

When the Romans reached Britain, one of the things which commended the island to them was its excellent oysters. Since then oysters have been extensively cultivated, but while a wild or native oyster reaches full size in about four years, the oysters on artificial beds take about three years more to reach maturity. Each one produces from 600,000 to 1,800,000 eggs every season. Above is a warty snail with the broad white band of spawn that it produces. This is of most delicate beauty and measures several times the snail's own length.

Schensky

SCAVENGERS OF THE COAST THAT SOMETIMES GET LEFT BY THE TIDE

Any decomposing flesh is eaten hungrily by the lobster, who thus performs a most useful service in helping to prevent the shore from being littered with putrefying matter. Big lobsters keep to the deep water, but occasionally one may be encountered in some rock pool where it has become temporarily imprisoned by the outflowing of the tide But small lobsters may be quite often seen, sometimes entirely out of the water in some cranny The lobster swims backwards by doubling itself up suddenly and giving a forward sweep to its tail.



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HOW SPIDER AND HERMIT CRABS PROTECT THEMSELVES

Our lower photograph shows one of the strange spider crabs, seen on the left. It is very clever at disguising itself so as to be almost invisible. Next to it is a hermit crab, which also forms the subject of the upper photograph. This crab is also called the soldier crab, and it has received these names because, having no shell of its own, it must go and find one belonging to something else, such as a winkle or a limpet. When it has grown out of its first small shell it is liable to covet one belonging to another crab and to fight for possession.

Sponges make a framework of minute needle-like spicules of lime or silica, or have a horny skeleton like the bath sponge. That and their disagreeable smell render them distasteful to most other animals. The commonest British species is the crumb-of-bread sponge (*Halichondria*), so called because when cut through it is seen to be full of holes like well-risen bread. Its sharp, curved spicules are made of silica, each about a two-hundredth of an inch long and one five-thousandth of an inch wide. It varies in colour, green, brown, or yellow, and in shape from a thin encrusting layer to large masses several inches thick. Another sponge, well known because of the immense destruction it causes, is the boring sponge (*Cliona*). It penetrates limestone rocks, causing them to crumble away, and is a perfect pest on oyster-beds, burrowing into and perforating the shells.

One of the most beautiful sights of the seashore is a rock pool, with its fairy world of miniature forests and living flowers It is the home of the polyps, loveliest of shore inhabitants, and here in their full perfection we find the tiny, fragile, delicately-tinted builders of the sea fir and coral colonies, as well as the bright, flower-like sea anemones.

THE "miniature forests" of the sea firs were long thought to be seaweeds, and it was only about a hundred years ago that a doubt arose as to their plant nature. Then the name of zoophyte was given, meaning "animal-plant." Later they were recognized as true animals and called hydroids (from their resemblance to the fresh water polyp hydra), and the plant structure was seen to be merely a horny protective sheath covering the stems and forming the little cups at the sides of the branches in which the polyps dwell. From these they rise as the tide flows and expand their tentacles in the search for the minute creatures on which they feed, and into them they retreat as the water ebbs again. A living sea fir colony is a revelation of beauty, its branches starred with crystal polyps each "at the diamond door of his house in a rainbow frill." Some are phosphorescent, like the obelia on oarweeds (*Laminaria*), which glows with a bright, opal-green light when the fronds stir in the darkness. There are innumerable species of hydroids ranging from an inch to a foot in height.

All the polyps, hydroids, jellyfishes, anemones and corals, are armed with very powerful weapons in the shape of batteries of stinging cells, which can be shot out with great force, to paralyse the prey or stun an attacking enemy.

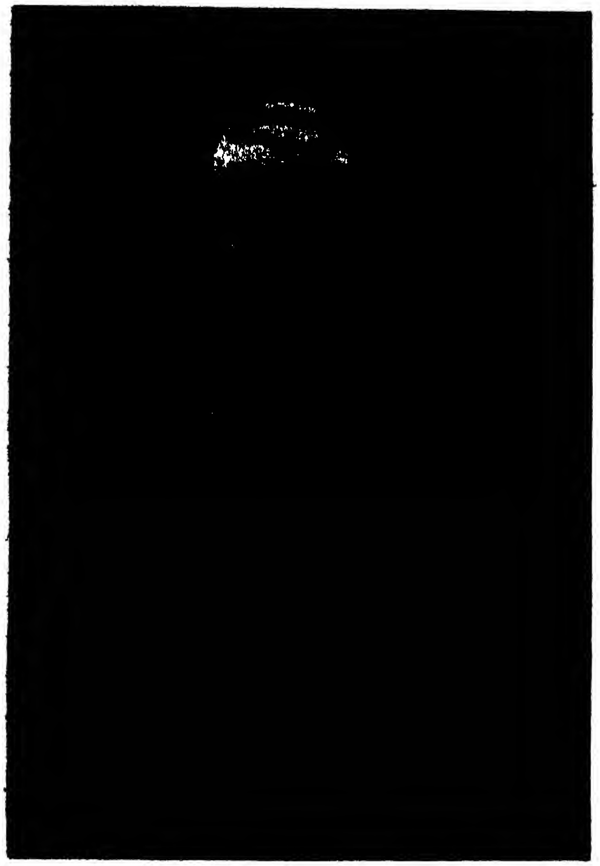
In the beadlet anemone, the commonest of the British anemones, the stinging batteries can be easily seen behind the tentacles as a circle or necklace of shining blue beads, each bead containing a battery. Some anemones have additional weapons, called *acontia*, long threads crowded with sting cells which they shoot out in masses from the mouth and sides. The threads are as much as six inches long in the parasitic anemone, so it is not to be wondered at that fishes give a wide berth to the hermit crab which carries one of these protectors. Fortunately the stinging-barbs are too weak to be able to penetrate the human skin.

SEA anemones are a never-ending source of interest. Anemones are found in the greatest numbers in places like estuaries, where the currents bring a continual supply of food, for, in spite of the dainty appearance of these creatures their appetites are enormous and nothing comes amiss to them. They differ in habits; the beadlet wanders over the rocks even up to high water mark, where it can be found under the seaweed closed into a small red lump waiting the return of the tide; the daisy anemone likes the rocks; the vestlet (*Cerianthus*) makes its "vest" or coat-covering in the mud; while the hermit crab anemones choose a shell in which a hermit crab lives. The big whitish Parasitic anemone (*Adamsia polypus*) is usually associated with the large hermit or soldier crab (*Eupagurus Bernhardus*); the velvet cloak (*Adamsia palliata*) which looks like white velvet spotted with red, lives with the little hermit (*Eupagurus Prideauxi*). Tiny brilliant Jewel anemones (*Corynactis*) can be found about low water mark in clusters on the vertical faces of the rocks, scintillating in all shades of colour, from rose, lilac, emerald, orange and scarlet to pearly white.

Little sea-gooseberries, or iridescent fireglobes, are sometimes to be found in rock pools, brought in by the tide. They look like delicate transparent globes, colourless when at rest, but gleaming iridescence as they swim. The two long tentacles are seen sweeping the sea for prey, but they can be drawn right back into two deep pits in the body. Each tentacle is covered with sticky cells called "glue cells" or "lasso cells" which contain spiral threads and catch the prey by entangling it.

WE cannot go far between tide marks without meeting some of the Echinoderm family, which get their expressive name "prickly skins" from the spines, or prickles, of carbonate of lime. The sea-urchin, feather-stars, and brittle-stars have hard skeletons of lime; starfishes a limy framework covered with a leathery skin; while the sea-cucumbers have soft bodies, but numerous limy prickles in their skins which make them rough to the touch. Anyone picking up the prickly ball of a sea-urchin or the flat five-rayed starfish might well wonder how such helpless-looking creatures could possibly move, but put them down in a rock pool and in a few minutes the riddle solves itself. Down the sides of the urchin and under each ray of the starfish hundreds and hundreds of tiny delicate tubes appear, stretching out and feeling round until they touch something, to which they fix themselves by the "suckers" on their tips. These are the tube-feet which are kept filled with water by mechanism inside the animal, and can be pushed out or drawn back at will.

The sand-urchin, which makes a burrow eight or nine inches below the sand, has another use for some of the tube-feet round its mouth. These are of



Schensky

MEDUSA OF THE SEA

This beautiful jellyfish is the cornflower-medusa. The medusas are named after Medusa, the Gorgon, whom Perseus, the Greek hero, slew. The long tentacles of the jellyfish are reminiscent of the Gorgon's hair, which consisted of snakes

enormous length and can be pushed up to the surface where they collect minute creatures for food.

The edible sea-urchin's masses of eggs are used for food in many places; one female it is calculated will produce twenty million eggs in a year. The small purple-tipped urchin is common under stones, but difficult to find owing to its curious habit of dressing itself in bits of seaweeds and shells. Besides the "five-fingers" starfish common on the beach, we can find the red and white sun-star with twelve or fifteen rays; the big five-pointed scarlet cushion-star; the starlet (*Asterina*) or small greenish-yellow cushion-star, in the rock pools; brittle-stars and sand-stars, called snake-tails from their wriggling snakelike movements; and occasionally a feather-star cast up by the tide, with its arms covered with rosy plumes.

The sea worms are often despised because they are "worms" but it is only a case of "giving a dog a bad name." To anyone with patience enough to watch them as they come out of their hiding places their gorgeous colouring and graceful movements will be a delight. It is not possible to give any idea of these in a photograph. It seems difficult to believe that the sea-mouse, or gold-mouse (*Aphrodite*) is a worm at all when we look at its mouse-coloured furry back, and the fans of iridescent hairs on its feet, shining green and gold like a humming bird's plumage.

Another, the fan worm (*Myxicola*) makes a gelatinous tube in which it lives, embedded in the mud, expanding its beautiful crown of feathery gill-filaments above the entrance in search of food, but shrinking back at the least alarm.

Many worms build dwellings for themselves. The quill worm (*Hyalinoecia*) makes a transparent tube just like a goose quill about three or four inches long, with valves inside, which allow of its coming out but prevent other worms entering. The sand mason (*Terebella*) collects sand grains, mixes them with mucus, and uses its lips as trowels to plaster them in position. Its tubes stick straight up, about an inch above the surface, each with a fringe of branching sandy threads at the end. The common lob or lugworm (*Arenicola*), used as bait by fishermen, forms U-shaped burrows one to two feet deep, and works down by swallowing the sand in the same way as earthworms do, throwing out the castings at one of the tube entrances. As many as three to four millions have been found on a mile of beach between tide marks. The boring worm (*Polydora*), about half an inch long, is a most destructive creature, which bores U-shaped tunnels or burrows in rocks or oyster shells. If danger threatens at one end of its tunnel it can turn round and escape by the other.

Everyone knows the Crustaceans, partly because so many of them, like crabs, lobsters, prawns and shrimps, are used for food, and partly because it is impossible to spend any time on the shore without

C. F. Gill

MARINE WORM

There are many worms of the sea that are not at all worm-like in appearance, and this one, which frequents the shore, is the fan worm. Most worms possess a nervous system, and these have a digestive tube and a mouth provided with horny jaws

Mussel

Limpets

Razor shell

Whelk

SEA SHELLS OF THE SHORE

Shell fish form one of the staple articles of diet for fish as well as man. All those seen here may be found on beach or rock along the coast of Britain. The most curious looking is the shell of the razor fish, which spends its life buried upright some distance down in the sand. The photographs are by S. C. Johnson.

some of the family intruding themselves on our notice, the sandhoppers on the sand, or the agile shore crabs on the shingle. They go through several changes before full growth is reached, and as the hard skin or shell will not allow of stretching to meet the growth each change must be prefaced by a moult.

Prawns (*Leander*) and shrimps (*Crangon*) are often confused one with the other, although they are really quite different, and live in different localities, the prawn in rocky places and the shrimps on sandy shores. The prawn has a long beak or horn in front, and both pairs of its feelers are long and delicate, while the shrimp has a very short horn and large scales at the base of its second pair of feelers, which it uses as shovels in burying itself when alarmed.

The chameleon prawns (*Hippolyte*) change their colour in a very striking way, red, green, or brown, to match the seaweeds among which they dwell, and even vary their markings, blotches, bars, or fine lines, according to the character of their surroundings. Innumerable crabs are to be met with on the shore. The common shore crab may be seen scurrying along amongst the shingle, the large purple swimming crab hiding among the stones, small edible crabs tucking in their legs and shamming death as soon as they are disturbed, whilst deep in some dark hole a lobster may be discovered guarding its chosen home. Some have very curious habits, like the hermits, which live in empty mollusc shells, the pea crabs, which hide in the shell of a living mussel, and others which dress themselves in seaweeds.

The whole shape of the hermit has been altered by its mode of life, the tail end being soft and twisted spirally so as to fit into the coils of the shell it inhabits. The soft-bodied little pea crab (*Pinnotheres*), which lives as a parasite inside oysters and mussels, sharing their food, gains shelter from its enemies, and neither harms its host nor is harmed by it.

Sandhoppers (*Talitrus*) are almost too well known, leaping and springing in the sand, or making shallow burrows in it. A near relative of theirs, the spectre shrimp (*Caprella*), can be found on the hydroids and small seaweeds, moving about like a looper caterpillar, or holding by its hind legs and standing straight out just as a stick insect does. Another relative, the Jassa, is found all over the world, building its tiny nests among the growths on rocks, buoys or piers, or on the bottom of ships.

The oarfooted crustaceans or copepods form a very important part of the "chain of life" in the sea. They feed on the microscopic plant life, and in their turn provide food for the fishes. Curlfooted crustaceans of various kinds occur in immense numbers. One, the rock barnacle (*Balanus*), often called acorn barnacle, because of the fancied resemblance to an acorn, covers the rocks in many places with sheets of tiny white cones. Each cone consists of six hard limy plates fastened to the rock, and has a hole at the top roofed over with a lid made of four movable valves. The noise made by the continual movement of the thousands and thousands of little roofs

can be clearly heard if one listens; 2,940 barnacles have been counted on a square foot of rock.

A young barnacle begins life as a swimming larva about the size of a pin's head, eventually settling down in a suitable spot and there cementing itself, head downwards. It changes its shape and develops the curling tendril feet with which it sweeps the water for food as if with casting nets.

DRIFTWOOD covered with ship barnacles (*Lepas anatifera*; goose-bearing) is often cast up by the tide. A young ship barnacle begins life similarly to the acorn barnacle, but settles on some floating object and grows a long fleshy stalk, sometimes more than a foot in length, with the body at the end. The shell is made of five limy plates, and through the slit-like opening the feathery curling tendrils are constantly pushed out. Ship barnacles are often called goose barnacles because of the old belief that they were the young of the bernicle or barnacle goose. Probably from being so often found on drifting wood, they were supposed to grow on trees, to drop off into the water and to hatch as young geese.

Molluscs are found everywhere in vast numbers, in spite of the legions of enemies which pursue them. Some, like the sea slugs and the octopus and cuttlefishes, have no shell; others make shells for themselves of carbonate of lime, and it is interesting to note how the shape, size and solidity of the shell vary with the conditions in which the builder lives. A cockle has developed a stout shell, almost globular in shape, to resist the pressure of the shifting sand as it burrows near the surface. A razor shell, on the other hand, driving a deeper burrow, has a long, flat shell to allow of a more rapid passage through the sand. Dogwinkles (*Purpura*), which live on a coast exposed to heavy breakers, make shorter and much more solid shells than the dogwinkles which live in sheltered places.

" To cling like a limpet " is a common saying, and it has been calculated that a force of seventy pounds is needed to move this small resisting object from a rock, but birds know that if they take a limpet unawares a sudden blow will dislodge it. Limpets, strange as it may seem, have a strong " homing " instinct, and always return to their pits or " scars " after a foraging expedition by following the track made on the outward journey. The noise they make feeding can be distinctly heard as they mow or scrape the weed off the rocks with their long tongues. The tongue of a limpet has been called a " living file." It is covered with about two thousand strong hooked teeth, which as they wear down in front are replaced by new ones formed behind.

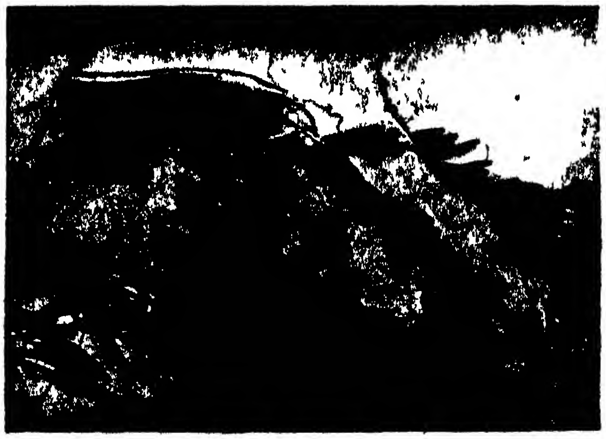
Periwinkles, like limpets, also feed on seaweeds, and have even longer tongues, and nearly double the number of teeth.

The mussel (*Mytilus*) spins a " byssus " or attachment of silky-brown threads on the rock where it settles, which it lengthens if the mud rises and threatens suffocation, or breaks when it wants to move to a new place. Tiny pearls are sometimes

Whelk's eggs

Eggs of Skate

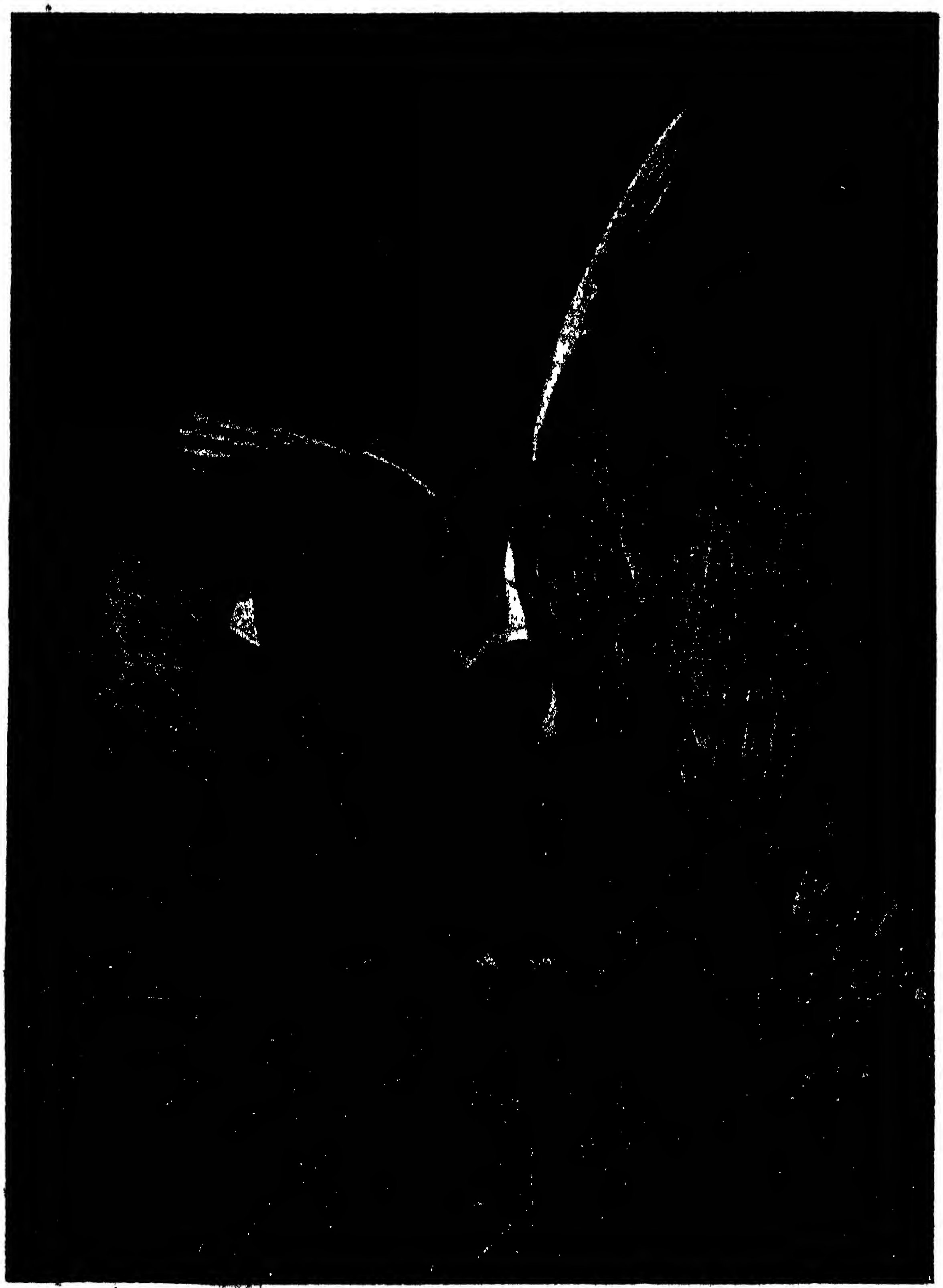
Eggs of the Sepia



Dog-fish egg

QUEER EGGS OF QUEER FISH

No one would imagine that the thing which looks like a black purse, with four strings, is really a case for skate eggs, or that what looks like a mass of some cooked cereal is really a clutch of whelk's eggs Both are very common along high-water mark. The photographs are by W S Berridge and F W Bond



A. H. Willford

BLACK-HEADED GULL COMES BACK TO ITS NEST

Britain's coast varies in physical character tremendously, and each variation has its own particular features of special interest. Where the seashore is bordered by sand dunes marram grass is planted to bind these hills of otherwise shifting sand together. The gulls which nest along the shore often lay their eggs in the open, so that part of the sand seems covered with pebbles. The " camouflage " is indeed perfect. But this black-headed gull has found a ready-made nest in a clump of marram grass and has laid her eggs there.

found in mussels, formed in the same way as are the oyster's pearls.

The oyster (*Ostrea*) is the most important of the molluscs used for food and is extensively cultivated. An oyster has from one to two million eggs. It discharges the young "spat" into the water, where they swim freely for about two days before they settle down for life. They look like tiny specks, about the size of a pin's head, each enclosed in two transparent shells. When they sink to the bottom they fix their shells on rocks or stones by the lower valve, and there remain incapable of motion. An oyster takes four years to grow to a marketable size.

King & Son

A H Willford

BUSY BIRD LIFE ON THE COAST

Below is a remarkable photograph of a common tern arranging her eggs with her beak preparatory to settling down to incubate them. Above we see a collection of razorbills and puffins collected on a rock. Most of the puffins, which are distinguished by their thick beaks, are lower down on the rock; while the razor-bills are outlined against the sky.

Razor shells are good for food, too. They are sometimes called spoutfish, because of their habit of shooting out a jet of water as they sink rapidly down their burrows.

The rockborers (*Saxicava*) and the large phosphorescent piddocks (*Pholas*) are very destructive, honeycombing the rocks with holes and tunnels like auger holes four to six inches deep. Their thin, delicate shells are covered with strong prickles.

A near relation of the piddocks, with an even worse reputation, is the shipworm or teredo, known from earliest times for the damage done to shipping and to all submerged wooden structures like piles of bridges, piers and wharves. It usually bores with the grain, and only changes its course to avoid a knot in the wood. The shipworm lines its long tunnel with a limy tube, and pushes out its "siphons" through the entrance of the tunnel, one taking water in and the other discharging the waste water and wood.

The sea slugs or Nudibranchs (naked gills) are very beautiful, delicate creatures of a wonderful variety of shape and colour. Each begins life with a tiny shell and later casts it off. The best known is the yellow sea lemon (*Doris*), about three inches long, often found on the crumb-of-bread sponge. Its strong tongue, set with about six thousand teeth, is used for scraping the surface of the sponges for a supply of food.

The octopus (*Polypus*), cuttlefishes (*Sepia*), and squids (*Loligo*) are the most highly organized of the molluscs. They are strange-looking creatures with curious bag-shaped bodies, eight or ten long writhing "arms" beset with suckers, staring black eyes, and mouths like parrot beaks. The animals themselves

are seen occasionally in rock pools, and the egg-masses are abundant in the summer months. The octopus lays thousands of eggs, attached to a central stalk, fixed on rocks or stones. The cuttlefish attaches its masses of black eggs called "sea grapes" to seaweeds, while the squid's eggs or "sea mops" are buoyant, and made up of numbers of long jelly-like sheaths, filled with eggs. One sea mop contains about forty thousand eggs.

In the rock pools and under stones many interesting fishes can be found lurking in crevices or attending to their family cares. Some haunt sandy places, like the sand goby which makes a nest by heaping up sand around an empty shell, and hollowing out a pit underneath. The eggs are laid on the inner side of the shell, and then the father mounts guard, driving away all intruders and fanning vigorously with his fins to keep water in circulation over the eggs.

THE butterfishes, male and female, take turns in guarding their eggs, and coil themselves around the mass. Sometimes they push the eggs into the holes bored by the piddocks, and mount guard near by. They are often called "nine-eyes" from the row of black spots on the back, or "butter eel," because of their shape and exceeding slipperiness.

Sticklebacks' nests are well known. The male makes a nest as large as a man's fist in the growing seaweed by spinning a silky elastic thread, and then swimming round and round the weed, binding it with the thread. The wrasses, too, make nests of seaweed to hold the eggs, and guard them while the young are hatching.

The common blenny or shanny is a very active climber, getting easily about the rocks by means of its large, fan-shaped breast fins. It eats the acorn barnacles, biting them off with its sharp teeth. Another quaint little fish is the father lasher (*Cottus*) or bull-head, so called from its habit when irritated of swelling and erecting two spines like horns on its head. It lives in rock pools and amongst the tangles.

Quite a number of insects frequent the shore, and are exceedingly interesting from the point of view of adaptation to an amphibious life. Fleshflies, black-flies (*Coelopa*) and midges swarm among the jetsam on the beach, where the heat of the decaying weed helps the hatching of the eggs. One of the most abundant kinds is a tiny wingless blue-black spring-tail (*Anurida*), which is able to retain enough air in its thick hairy coat to last it for four or five days under water. A wingless bronze-coloured beetle, *Aepus*, which runs about over the stones and weeds at low water, is specially adapted for long periods of immersion. It has two air sacs and, in addition, the air contained among its covering of hairs.

GREAT numbers of birds frequent our shores, some resident all the year round, others, the migrants, gathering from far distances and visiting us at their nesting seasons. The Farne Islands, Bass Rock, St. Kilda, Ailsa Craig and the Scilly Islands are among the most famous of the breeding haunts. Here the sea birds congregate, nesting in bewildering numbers on every available ledge and cranny of the cliffs, or on the shingle at the foot of the rocks, often so tightly packed together that movement seems all but impossible. Here myriads of the Auk tribe pass the summer months, occupied with family cares. From these centres they scour the seas around for the fishes or floating plankton on which they feed, scurrying over the surface with rapid beats of their short wings, or diving under in chase of their prey. The common guillemot and razorbill make no nest of any kind, but lay a single egg on the bare rock, and hold it lengthwise across their feet during incubation. The puffin chooses a warm underground burrow for its egg, either excavating one for itself with its little red feet or taking possession of a rabbit's hole. The sea parrot, as the puffin is often called, is one of the most interesting of the shore birds, its comical appearance and habits marking it out from all the others. The large, brightly coloured, parrot-like beak banded in blue, yellow and red, is only a sheath assumed during the breeding season. With the passing of summer and the return of the puffin to its nomadic existence on the ocean, the sheath is cast and the true bill is seen, black and smaller.

THE sea-gulls are with us all the year round, haunting the stretches of shore uncovered by the tide, or gathering in flocks in the harbours and estuaries, circling and screaming in the fight for food. Their graceful soaring flight and wailing cries are well known, even far inland. They are marauders all, levying toll on the weak and defenceless, but the worst and largest of them is the great black-backed gull, a powerful bird with a wing spread of nearly six feet. His breeding places are strewn with the remains of his victims—guillemots, puffins, shearwaters, and even other gulls. The black cormorant, with its white patches on throat and flanks during the breeding season, and the green cormorant or shag, are as well known on our coasts as the gulls. Whether fishing, or sitting upright on the rocks drying their feathers, or flapping heavily back to their nests with fish for their young, they are easily recognized by the long, slender neck and bulky, bottle-shaped body.

Many other birds may be seen on the shore, either nesting or foraging for food, the oyster-catchers with their black and white plumage and red legs and bill, diligently hunting for winkles and barnacles, redshanks wading in the mudflats, catching small crustaceans and molluscs; ringed plovers, curlews, sandpipers, terns or sea-swallows, with their graceful dipping flight, fishing on the wing, and the little rock pipit building its nest not far from high-water mark.

This glimpse of the shore with its teeming life, its beauty and colour, would not be complete without a passing mention of its largest and most elusive inhabitants, the great grey seal and the common seal. They must be sought on the wildest parts of our coasts, where on the rocks at the base of rugged cliffs they may find safety for their young.

Chapter XXIX

The Wild Mammals of the British Isles

By Lewis Spence

Author of "An Introduction to Mythology"

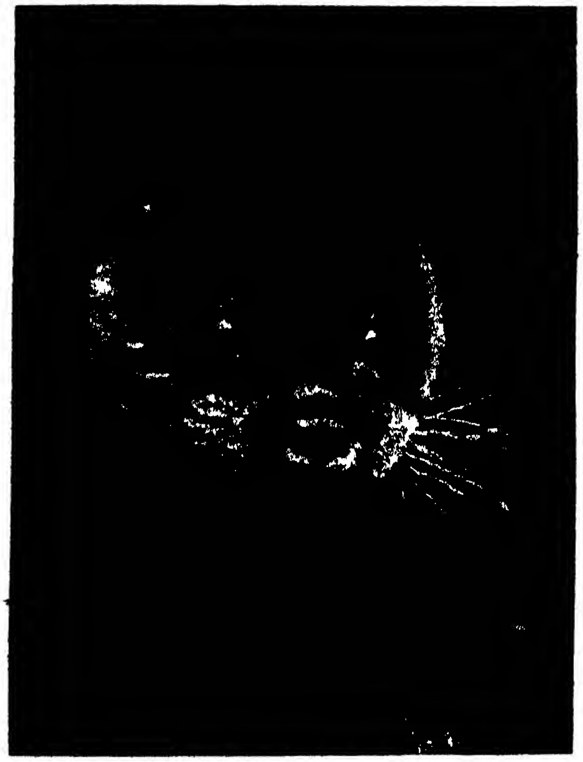
WILD life in the British Isles has dwindled almost to vanishing point in many localities, and our native feral types are few and dwarfish when compared with those of the Continent, where the wolf and the wild boar survive. Still, it is an intriguing and goblin fellowship which continues to haunt our little wildernesses. With the exception of "the red deer and the roe," British wildings are diminutive in scale, as befits an insular economy, and harmless enough to man. Reynard is the pierrot of the lupine race, the wild cat a fairy tiger, the badger a striped harlequin for whose reprieve thousands of hands, both childish and elderly, are raised in appeal. Even the polecat has his defenders and his poets, and the weasel his legends, and surely the most charming folklore in the world clusters around the island zoology, cherished by all save, perhaps, a handful of disenchanted gamekeepers or shepherds who have their own reasons for drawing long faces when Brock or the Gentleman in Red are mentioned in their hearing.

"The noblest among British wild animals," as the red deer (*Cervus elaphus*) has been called, is also the most important both from the point of view of the naturalist and the sportsman. Had his existence in the north not been most earnestly fostered for purposes of sport, he would assuredly have become extinct generations ago, as, contrary to popular belief, he does not thrive on the bleak uplands, but prefers the lower levels and sheltered glens and woodlands. His ultimate fastnesses are the Highlands of Scotland, Cumberland, and Exmoor. I am afraid artists have depicted him as more stately and more bulky than he really is, for the average stag weighs about eighteen stones, and the hind considerably less.

In Scotland the red deer feeds principally on the heather and in winter, like the reindeer, scratches up the snow with his hoofs to get at the lichens and mosses beneath. But, above all, he prefers the soft grass by the burnside—or wheat and turnips, if he can come at them in the croft of the smallholder. He has also an intense craving for salt, which he will travel miles to glut, and in winter frequently makes his way to the seashore, where he eagerly devours immense quantities of seaweed.

During spring he is busy growing antlers and putting on fat. With the advent of October, the mating season, he goes forth in all his might to do battle with his fellows for the favours of the hinds, a furious and formidable fighting-machine indeed, trampling the earth as he goes, and roaring incessantly until he encounters another stag which has succeeded in gathering a female following. The calves are born at any time between May and July, and remain with the hinds till the late autumn.

The stag usually casts his antlers in February, although in the Highlands they may fall as early as Christmas. A stag with three points crowning each horn is known as a "royal," and the average span between the antlers is, perhaps, forty inches. He casts his winter coat about the same time as his horns, while the hind carries hers until well into May.



AN OTTER STARTLED

Next to the badger, the otter is the largest wild carnivorous animal left in Britain. From snout to tip of tail it measures about forty inches. Thus it is about the same length as the badger, though it is lighter in weight.

The roedeer (*Capreolus capraea*), a forest variety of the cervine race, chiefly occupies those woodland districts in Scotland which have been vacated by the red deer, and is also to be found in Cumberland and the New Forest. Its cunning is proverbial among sportsmen, and the crack of a rifle is certain to send it galloping to some trackless shelter where probably no hunter has yet succeeded in following it. Unlike the red deer, it is monogamous and mates in June. Naturally, as a citizen of the woods, it is partial to foliage, and has a surprising reach which enables it to stretch to branches considerably above the ground.

The bucks are apt to be irritable in the mating season and may even attack the human disturber of their haunts. In May the roe grows a light russet coat, but towards October this shades into a

W. S. Berridge

LARGEST OF THE BRITISH MAMMALS

Roedeer (bottom) are found in the New Forest and Cumberland still wild, and in Scotland The latter country is the chief home of the wild red deer (centre), though he is also found on Exmoor. The fallow deer (top) is the usual deer of the private parks.

heavy brown. The antlers of the roe, however, never approach the majesty of those of the red deer and seldom measure more than eight or nine inches in height. In the wooded parts of the Highlands one grows familiar with the short, sharp bark of this graceful little deer, which is nearly always in sight of the peaceful visitor to his demesne.

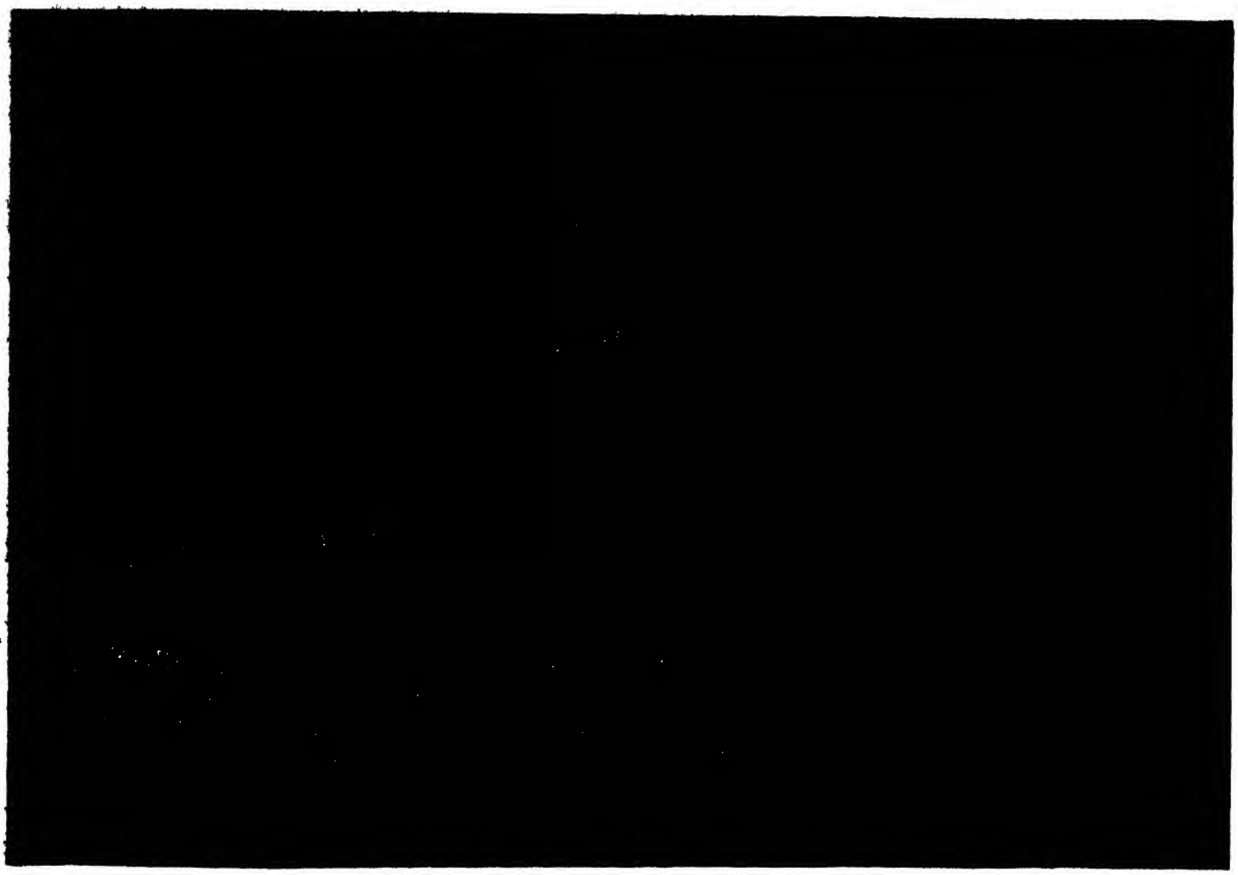
THE fallow deer (*Cervus dama*) is smaller than the red deer, and is of a pale red colour, spotted with white beneath. There is a marked distinction in the form of the antlers, those of the upper branches being flattened and expanded. During the breeding season the fallow deer runs in mixed herds, and is then very destructive to growing timber. The fawns are born in May or June.

I have often wondered who knows more about the fox (*Canis vulpes*), the people who hunt him, or those who do not. Nobody loves him, save, perhaps, the master of foxhounds, the naturalist, and the poet, and those for reasons far enough apart. In the mountainous parts of Scotland he is a very different animal from the harried mange-stricken beast of the English shires, where a nerve-wracking life of continual hazard induces disease and premature exhaustion. See the Highland fox in his glory—" The Red Dog " as they call him in some parts of the north—and you appreciate the difference between Rob Roy and a pickpocket

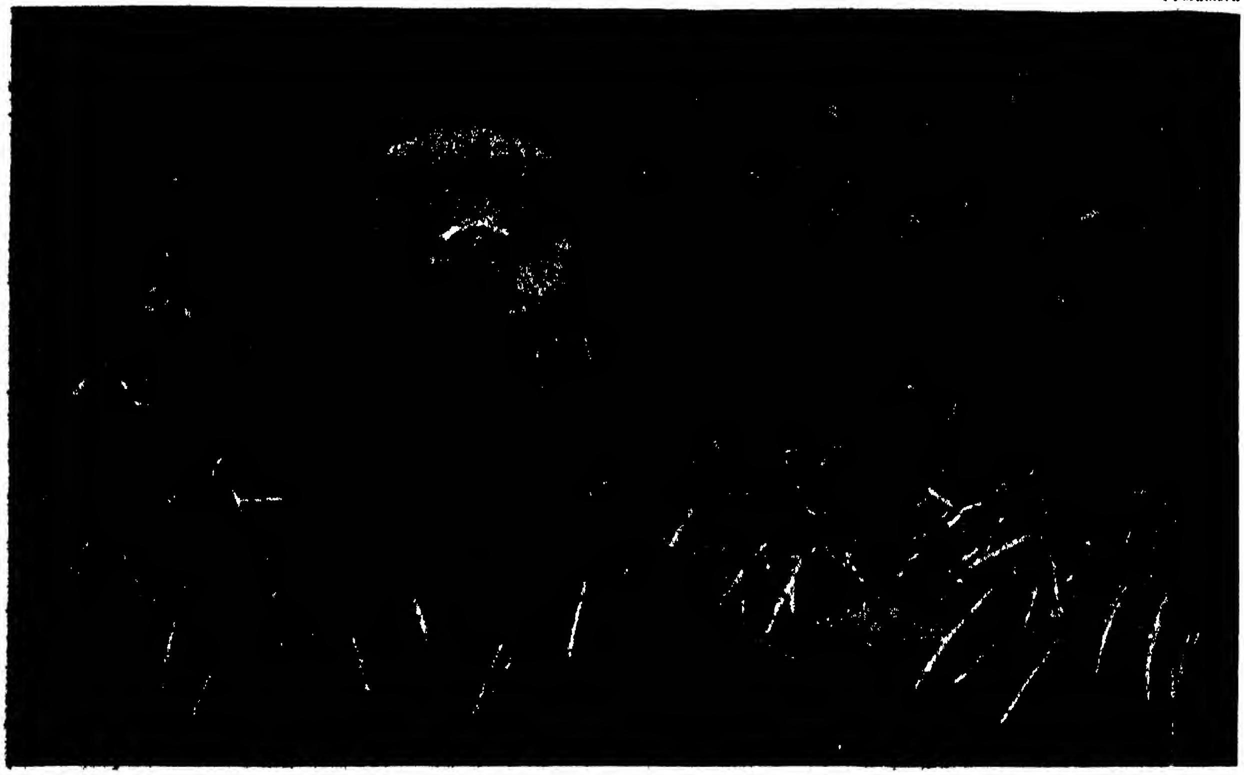
Clever as most of us believe him, we yet do not give him sufficient credit for an intelligence approaching the mysterious. As a mimic he can hold his own with the parrot or the mocking-bird, can imitate the bleat of a lamb or the squeak of a rabbit, can smell steel traps yards away and knows how to dissipate his tell-tale scent by losing it in the tarry, oily odour of a railroad track. In the shires he is the hunted thing par excellence and not the otter himself can better imitate a bundle of rags drifting down a stream, nor can the weasel more deftly fit himself into a background of bracken and leaves in natural and very effective camouflage.

His peculiarly pungent and unmistakable scent is his undoing, and he knows it. The glands at the root of his tail are to him like the antlers of the stag, things of perilous betrayal. Unlike the witches, he loves running water, which alone can break the spell of his unfragrant track. But escape to him is often as disastrous as death, for with broken heart and shattered lungs, he may lie in a damp drain unable to move for days, contracting the fatal red mange, which leads slowly to an agonising death. This, not infrequently, is the sequel to his thirty-miles-an-hour marathon for life. That magnificent brush of his, which he uses as a species of rudder to balance his turnings and dartings when hunting on his own account, is a dreadful hindrance indeed when it is his turn to be hunted.

Born in luckless April, his dam puts him through an early course of mousing. The cubs are assiduously attended to by their father, who often goes far afield for his provender, and does sentry-go at the

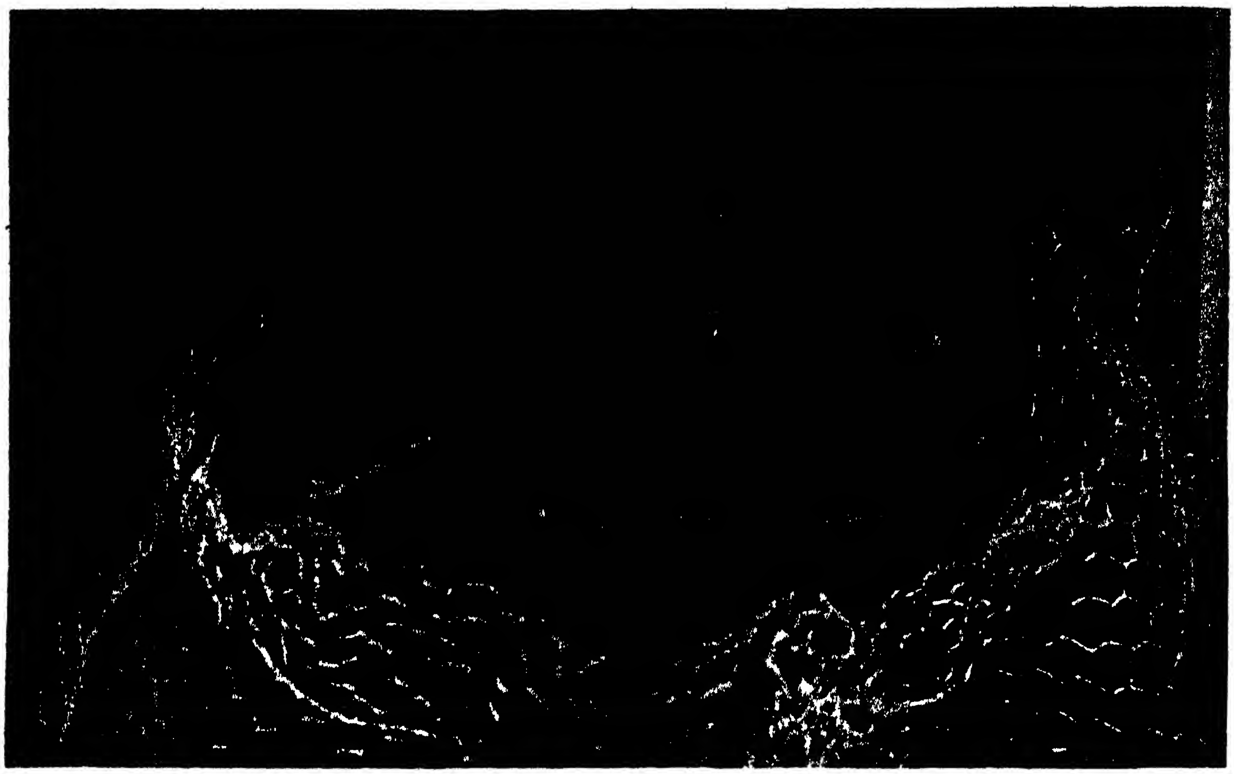


W. Parkinson



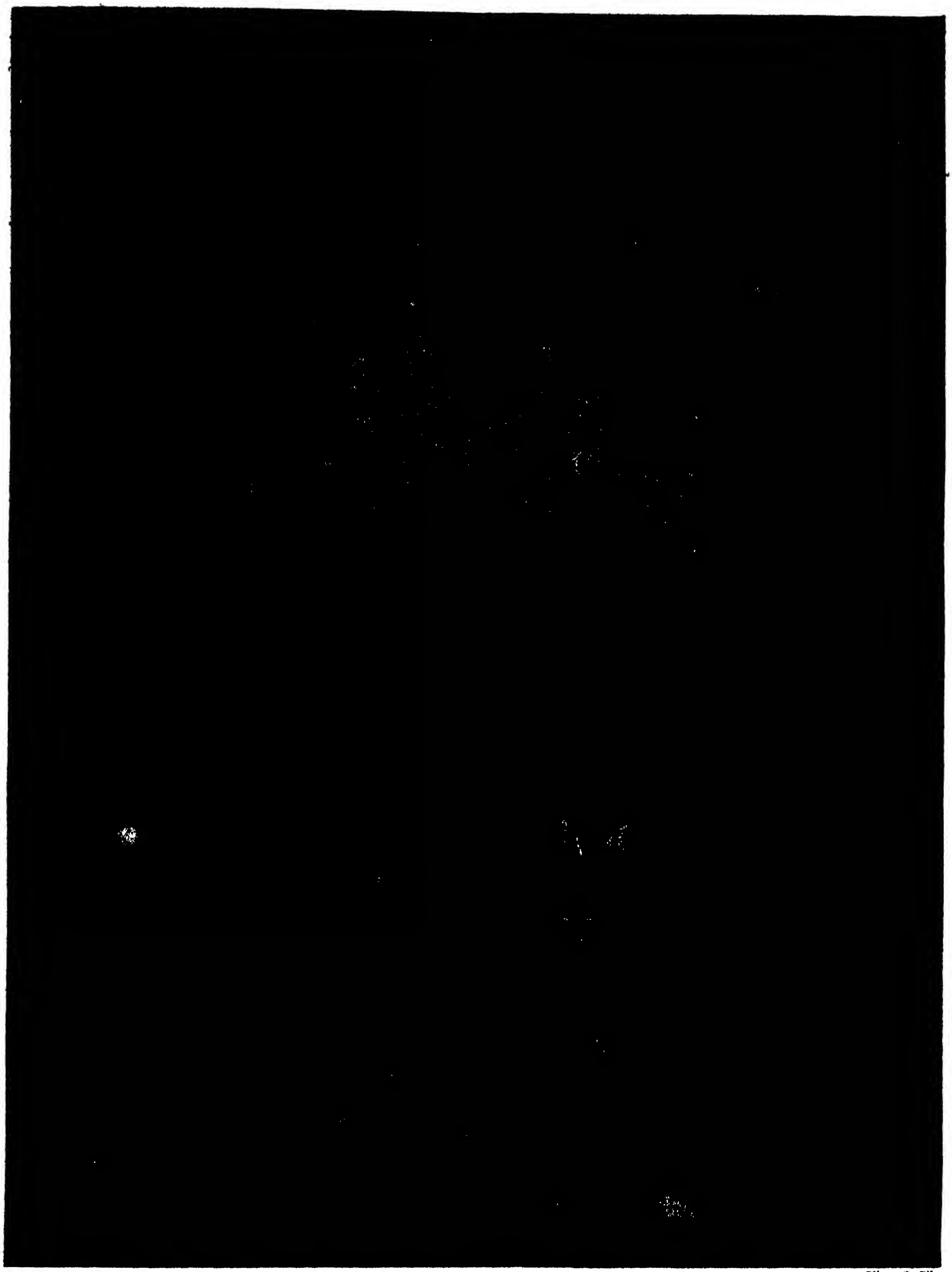
THE OTTER IN HIS HAUNTS BY BROOK AND SEDGE

Although the otter is such a fine performer at under-water swimming, it has at first no desire to get to the water. Indeed, otter cubs are very frightened of the water and have to be taught to feel at home in it by the parents. This seems to prove that the otter's ancestors were not originally aquatic, but that succeeding generations gradually adopted this form of existence. The otter's most annoying habit is the one of taking just one bite out of a fine salmon and leaving it. But it likes eels even better.



RED REYNARD AND A LITTER OF FOX CUBS

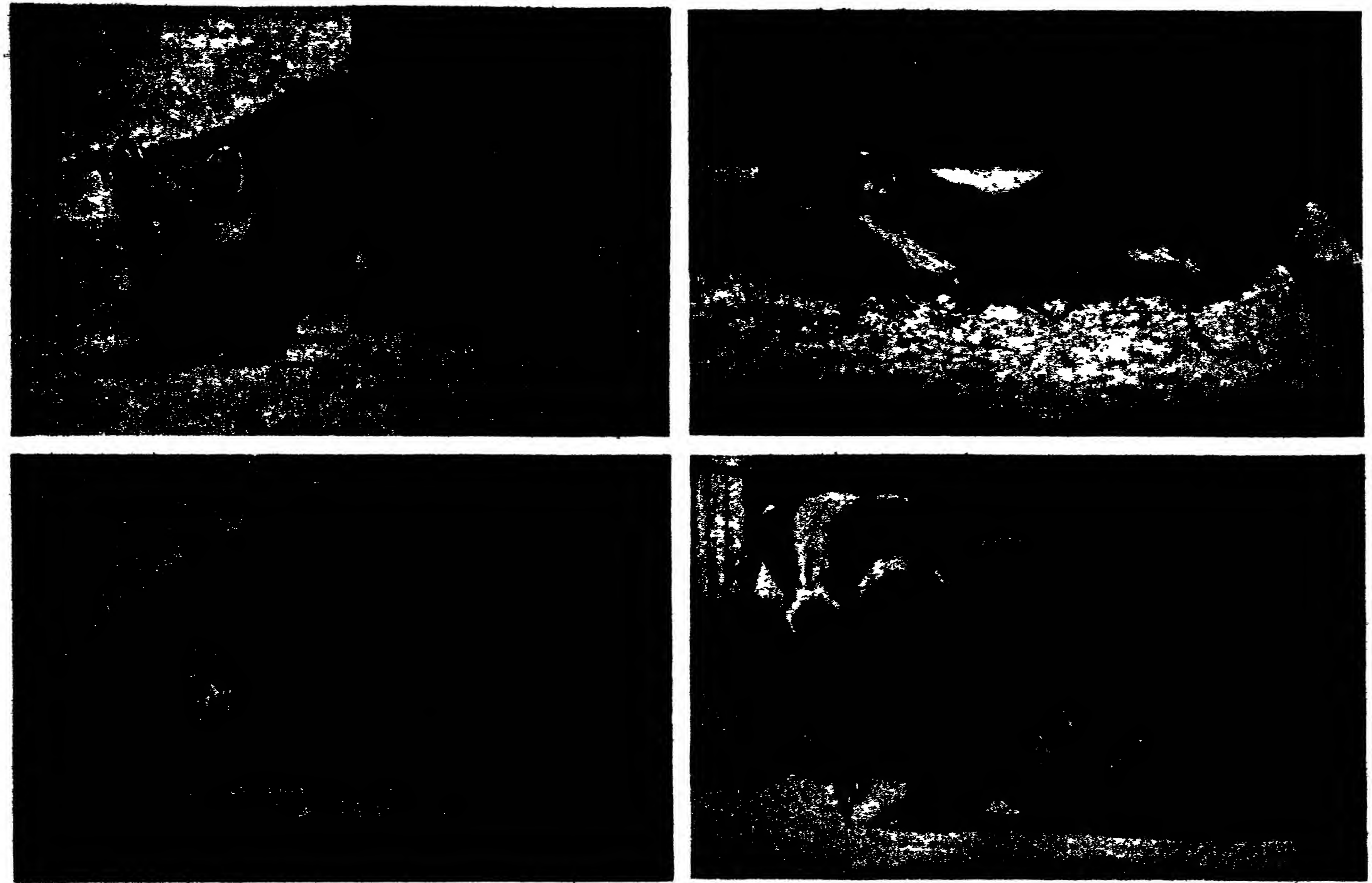
Hunting being carried on far more intensively in England than in Scotland, it follows that the Scottish foxes are finer, less harried specimens than those of the English "shires." The litter of cubs seen above was found in the district near Perth by a gamekeeper, and was sold to one of the Scottish hunts for breeding purposes. This sort of treatment has been responsible for the fox's survival in the hunting districts where farmers would otherwise have exterminated it. But in the wilder parts of Scotland the fox still flourishes naturally.



Oliver G. Pike

. FOX CUB LEAVES HIS LAIR IN THE WOODS

Best known of Britain's wild animals is the fox, which owes its preservation to fox hunting. For if this national sport had not needed the fox that animal would long ago have been exterminated by traps and poison as a pest Foxes are born about the month of April, and there are usually four or five to the litter. In September, when the huntsman's work of entering young hounds begins, the fox cubs get their first experience, in what is called cubbing, of the institution has which preserved their race.



W. S. Berridge

WILD CAT, BADGER, PINE MARTEN AND WEASEL OF BRITAIN'S WILD

Probably the pure-bred wild cat no longer exists in Britain, since it has mingled its blood so frequently with that of the domestic breed which has gone wild. Cumberland and Scotland are the homes of the wild cat (bottom left), which can be distinguished from the ordinary cat that has taken to the woods by its larger size. The badger (bottom right) has for generations been senselessly hunted towards extinction. It is one of the shyest and most difficult animals to see, however, and is a marvellous digger. The pine marten (top left) is still occasionally seen in Wales, the Lake District, and Scotland. It is about two feet long and a fine tree climber. The weasel (top right) is the fiercest animal in Britain and a great slayer of rats and field mice.

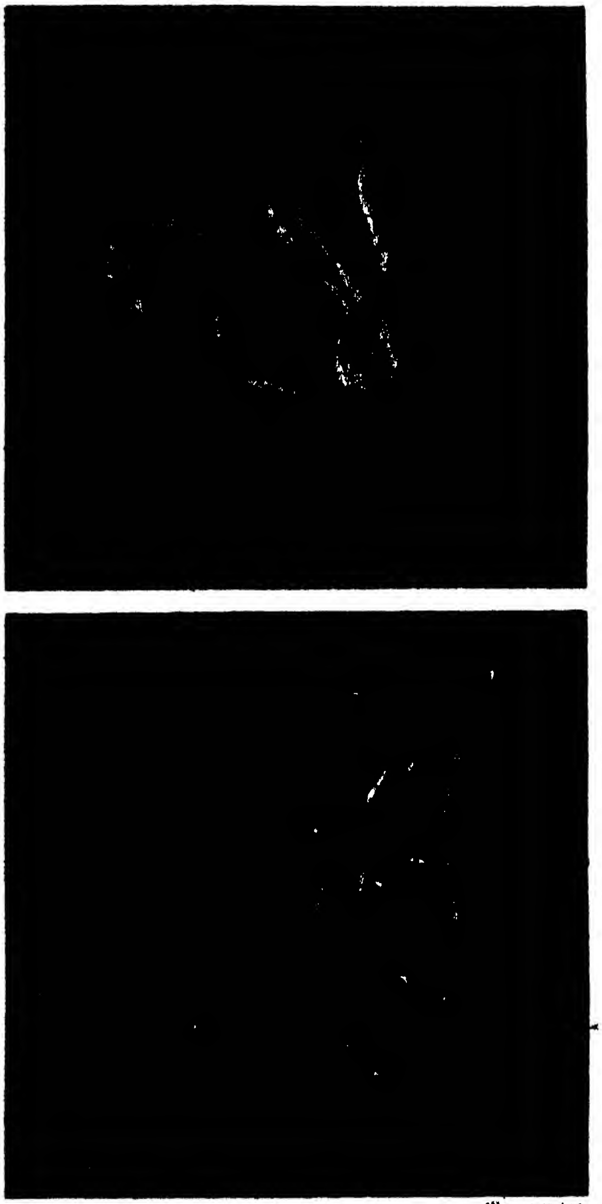
mouth of the den. It is, indeed, such excursions, made in the anxiety of parenthood, which earn Reynard so detestable a reputation as a poacher. But he is a model sire. If you try to dig out a family earth you will not find the cubs in its main corridors, for they are almost invariably tucked away each in a little side-passage of his own. Cubs have no scent until the age of four months, and exhibit little of the skulking ferocity of their species. Indeed, I have heard that they are occasionally seen playing with rabbits!

Even the least sentimental will agree that the badger (*Meles vulgaris*) vanishes all too quickly, and that not merely through the trap-door of his earthy retreat, but into that deeper limbo where disappear the species which become extinct. It has been abundantly proved that he does practically no damage to game, and it is encouraging to find that, instead of hunting down this little bruin of Britain with terriers which he does not want to fight, landowners are actually advertising for him as an "embellishment" to their estates.

Brock is a forest denizen, and loves fir and pine woods and the sandy soil beneath them, which suits his tunnelling propensities. But he has almost vanished from the Highlands, and his principal habitats are Wales and the New Forest, that great southern asylum of Britain's feral life. His bodily markings, composed as they are of silver and shadow, prove him to be by nature nocturnal. There is none in the wild so cautious as he, and he is as seldom espied in the open as a centenarian in the Strand. He skulks along by the side of hedges, and along the gutters of fields, for his short legs and lumbering, bear-like gait make it impossible for him to move with expedition, and not infrequently he cleverly connects these runways with a side door from his earth.

The average length of the badger is about forty inches, inclusive of tail, and he weighs from thirty to thirty-five pounds. His provender consists of snails, slugs and beetles for the most part, frogs and worms, eked out on the vegetable side with roots and berries in their season.

As an excavator the badger can, for his bulk, easily beat all rivals, and indeed vie with the steam-shovel. Normally, however, he is sloth personified, sleeping through the hours of sunshine and coming to the surface only once in three or four days to gorge himself. If hunted over sandy soil, he will frequently dig in where he stands rather than run. His warren, which he occupies for a few months only, is marvellously planned, and as intricate as the labyrinth of the Minotaur. It is always freshly bedded, and in time he builds up a regular "kitchen-midden," as an antiquary would describe it, at the entrance to his burrow, consisting of disused litter and other rubbish. He has a wonderful system of communication with his fellows in "scratching-posts"—tree-trunks or rocks on which he leaves the marks of his claws, and in this manner, probably, secures his mate, the place of "registration" becoming also a rendezvous. As a fighter there is scarcely his equal in nature and probably no single terrier is capable of tackling a full-grown dog badger with any chance of success.



W. S. Berridge

HARE AND WILD RABBIT

The wild rabbit (bottom) would soon outnumber all the other countryside populations, but that the father rabbit has a habit of eating his own young and that rabbits have so many enemies. The hare (top) prefers open country and is solitary except at mating time.

In all likelihood no pure specimen of the British wild cat (*Felis catus*) now exists. One frequently notices the capture of these animals recorded in the newspapers, but the breed has become so mingled with the domestic species that it is only the comparative size of the wild cats so called which leads to the supposition that they are of the pure and pristine strain. Nevertheless, the domestic cat, when it takes

W. S. Berridge

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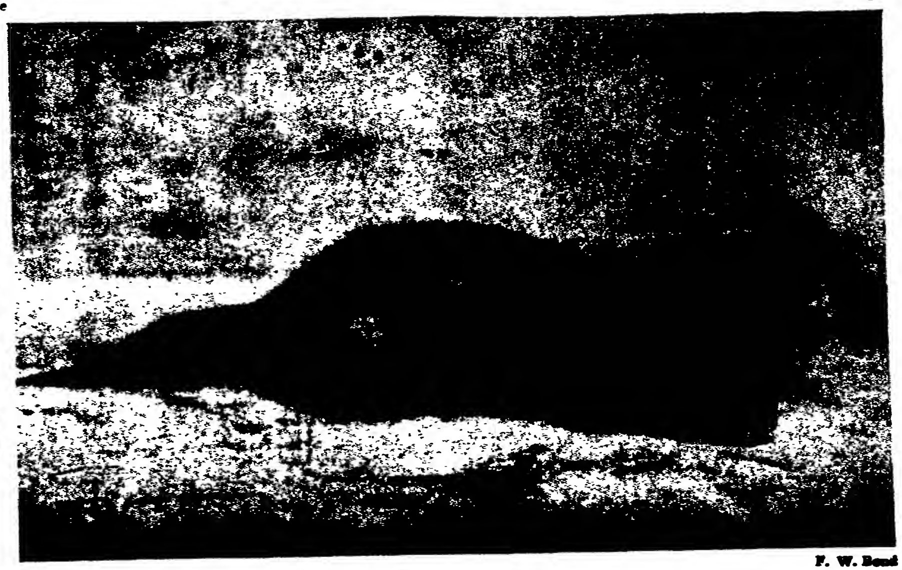


F. W. Bond

DESTROYERS OF ANIMAL AND VEGETABLE LIFE IN HEDGEROW AND WOOD

Making its home in banks or the hollows in trees, the stoat (bottom left) is hated by the gamekeeper for its destruction of game. The male attains a length of about ten inches, and the female is a little shorter. The hunting is mostly done at night. The polecat (bottom right) which is now extremely scarce, measures about sixteen inches long, tail included, and is renowned for its revolting odour. One of the beauties of the woods is the red squirrel (top left), but it is very destructive to saplings. This is partly compensated for by its habit of burying nuts for storage purposes. Those it forgets become trees. The grey squirrel (top right) is an American importation, and has largely ousted the more handsome native from the home counties.

to a wild existence, very speedily approximates to the appearance of the feral species and grows out of all proportion to its domestic relative. What we now call the wild cat strain probably comprises the remnants of the original *Felis catus* crossed with descendants of the domestic animal which have run wild. I believe that the domestic cat has nearly as much wild blood in him as the so-called wild cat.

Apart from its greater size—a wild cat usually measures from three feet five inches to three feet ten inches from nose to tip of brush—the tail is more bushy and distinctly ringed than in the tame species, the head is wider and the ears are much farther apart and stand out so that sometimes they seem almost to flap over the cheeks. The colour is usually tawny. The wild cat is a frequenter of the woodland, and his normal quarry is the squirrel, which he stalks with all the patience of his tribe. But, though he has a penchant for hare and rabbit, he prefers grouse or pheasant to any other flesh. This notwithstanding, he is exceedingly dangerous to lambs and even to young deer. He does not feast immediately after a kill, but carries his prey into the woods, where he devours it tiger-fashion, mauling it about at his ferocious ease.

Although he mates singly, he is a bad parent, and his one annual litter depends almost entirely upon the offices of the mother. Like Reynard, no one wants him, and were it not for his rarity and his picturesqueness the wild could well do without him. In his present impure strain he is confined only to Scotland and Cumberland, and were it not for the accessions he receives from the ranks of the tame species with which he interbreeds, he would speedily become extinct.

Weasels (*Putorius vulgaris*), stoats or ermines (*Putorius erminius*), and polecats (*Mustela putorius*) are all of one and the same family, the lower assassins and thugs of our woodland society. The weasel attacks any form of life in which warm blood runs, granted it be not too big or powerful, and no man-eating tiger displays half the desperate courage or blood-thirstiness of this demoniac little panther of the British countryside. Yet on the whole, the stoat is much more destructive among game, while the weasel confines himself more to rats, mice and water-voles. Even the bravest male rat, a fighter born, dreads him, and a well-plucked terrier has been known to run from him after experiencing the results of the first rough-and-tumble.

The weasel avoids the open, and in true cloak-and-dagger fashion skulks along walls and ditches, stalking his prey, actually terrifying it by his show of ferocity, moving after it by jerks, punctuated by sudden stops, relentless in his stalking as the timber wolf. His hearing is phenomenal, and his ability to identify himself with his surroundings is equally extraordinary. But strangest of all are the tricks with which he frequently beguiles his victims, throwing somersaults and executing such contortions that domestic fowls and game-birds, consumed with curiosity, draw near—to be devoured, or at least speedily strangled, by the murderous little acrobat.

Weasels and stoats are migratory, and sometimes travel in small packs. Occasionally they gather in regular armies, hundreds strong, when they have been found to be dangerous to human life itself, as many a Scottish shepherd knows. In couples they hunt together like well-trained hounds. But they are easy to trap, as they run along ditches and do not fear the scent of steel.

Yet they have their uses. They keep down the rat pest, and as their own food is chiefly composed of "rats and mice and such small deer" they are partly to be apologised for. The weasel's warren is widespread, but his numbers are strictly limited by the fact that he engages in death-duels so frequently with his own kind—and the ermine in his yellow, wintry coat is certainly valuable commercially.

The polecat, or foumart, grows more and more rare within the four seas of Britain. Of a dark brown colour in summer, he shades off to a lighter hue in winter, and his head is usually ringed with grey or white. He is a most destructive killing machine, larger than the weasel or the stoat, measuring usually about sixteen inches from nose to tail. Indeed, when one recalls his odour, he has nothing but his rarity to recommend him. He has a peculiar taste for frogs (when he cannot procure game), and has a trick of paralysing them by biting them through the nerves of the head so that he may store them in his larder alive. He usually nests in a disused rabbit-burrow. The young are born in May, and remain with the parents till almost full grown. The polecat hunts exclusively above ground and not, like the weasel, along the corridors or earths and burrows of the pine-woods of his affection. But, like some antiquaries, he has a peculiar taste for ruined buildings standing on the moorland wastes, and frequently rears his family among their crumbling stones.

The pine marten (*Mustela martes*), once common enough in the woodland, has paid the penalty of a handsome skin, and is scarce, except in Scotland, Wales, and the Lake District. He closely resembles a polecat, but his legs are longer, and his head broader and tail more bushy. The rich, dark brown body extends on the average for a couple of feet. He is an arboreal beast and an inveterate egg-sucker, although he has a penchant for ground fruits. His nest is formed of grass among rocks, or in a hollow tree.

The otter (*Lutra vulgaris*) is really an animal of the weasel species which has taken to the water, or rather to amphibian habits. He measures on an average about forty inches from snout to tip of tail, and weighs round about twenty pounds. Many rather terrible tales are broadcasted about his ferocity, both to man and beast, but the bare truth seems to be that he is a mere Paul Pry, insatiably curious or, perhaps, that like the puma, he has a leaning to human society. He is really as playful as a kitten and by no means destructive in the wanton sense

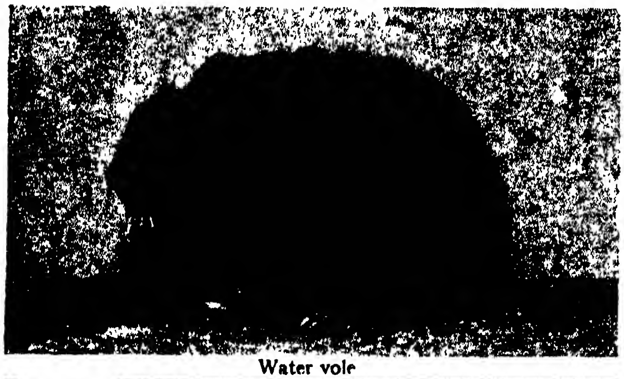
Indeed, he maintains the numbers of [illegible] by killing off eels and older trout which are apt to devour the growing fish. He certainly has a wretched habit of devouring only the "middle cut" from a prime salmon, but, given eels, he will leave salmon alone.

The speed with which the otter can swim under water is amazing. He is swifter than the sleekest salmon. As a cub, he dreads the water and has to be instructed in swimming by his parents, a proof that his habits were not originally aquatic. He works up the estuaries of rivers from their confluence with the sea, clear to the headwaters, and has his own definite landing-places. In winter he can unerringly pick out a trout from a frozen brook where the pools

No mammal, perhaps, thrives so well on the life of the hunted as the brown hare (*Lepus europaeus*). Naturally he is a good deal of a hermit, except in the mating season, and even as a leveret prefers his own society to that of his fellows, leaving his dam at the age of fourteen days. Like most rodents, he adheres to

Brown rat

Mole



Water vole

Black rat

House mouse

Harvest mouse

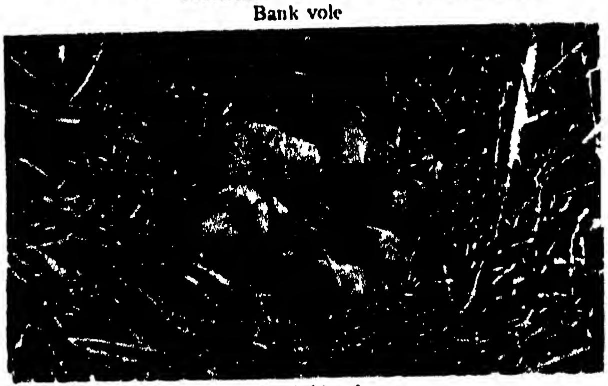
SOME OF BRITAIN'S SMALLER MAMMALS THAT LEAD FURTIVE LIVES

Of the house mouse nothing good can be said. It is a spreader of dirt and a carrier of disease. Its relative, the harvest mouse, is, on the other hand, quite a pleasant little creature, and is very engaging to watch as it hangs swaying from a wheat-ear, clinging by its tail. It is about two inches long. The old English black rat has in most places become displaced by the larger brown rat, whose depredations cost the country £15,000,000 every year The mole is valued for its skin and lives largely on worms Photographs by W. S.

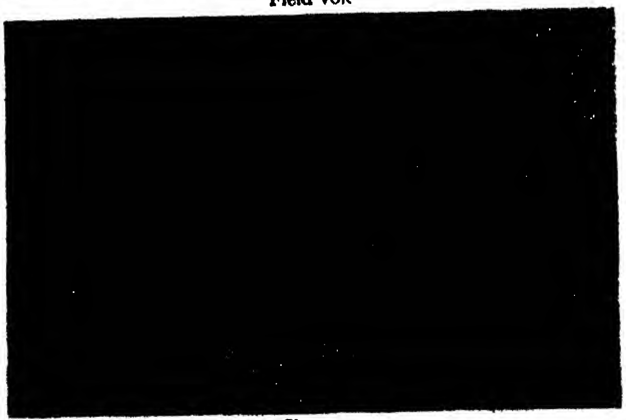
Long-tailed field mouse

Bank vole

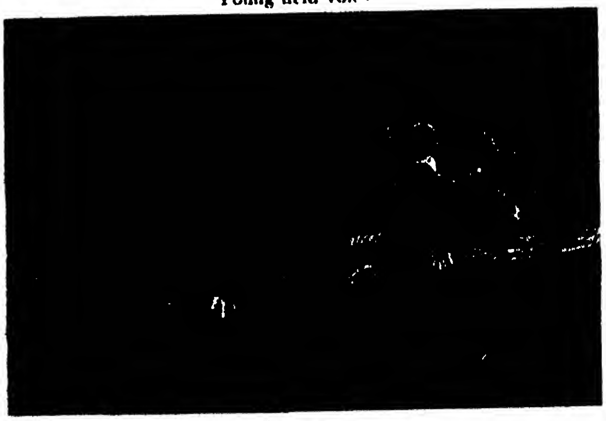
Field vole



Young field voles



Shrew



Dormouse

SHREW, MICE AND VOLES, THE PREY OF MANY CREATURES

A flexible, pointed snout distinguishes the common shrew, which eats no less than four times its own weight of insects in thirty-six hours The dormouse is quite as sleepy in fact as Lewis Carroll made it in Alice in Wonderland, and is often taken for dead. The field vole is a distant relative of the mouse and a curse to agriculture, eating up the newly-planted seed. The bank vole, keeps mostly to wild roots for its food, while the long-tailed field mouse is a robber of kitchen gardens Photographs by A H Willford and W S Berridge

nest in a shallow field-burrow and go to join forces with the communal warren.

The rabbit is always on the look-out for danger, and, when he senses it, tattoes on the ground with his hind legs in warning to his fellows, which can hear it roods away. In the Highlands flood or spate is his worst enemy, and he is constantly being washed out of his burrow or suddenly drowned in it. Also, the diseased house rat communicates his ailments to rabbits with disastrous frequency.

It is most necessary to keep rabbits down in sheep country, as they devour the grass, and a sheep will not eat where a rabbit has been. Rabbits begin to breed at about three or four months, and the rate at which they multiply is rivalled only by the rat's. They seldom pair for any length of time.

The squirrel (*Scioros vulgaris*) has only himself to blame if in many British districts he is on the verge of extermination, for nothing is so destructive to the woodland. He will speedily kill off a sapling, and even reduce a whole plantation to ruin, if not severely taken in hand. He is an inquisitive little beast, but has his retiring moments. Of all the wildings he is the food-hoarder par excellence, and can tell a sound nut from a bad one by its weight, burying the good nuts one by one in separate places, and recovering every one in the time of his need. He is thus a natural planter of forests, as those nuts he forgets become trees. He dislikes rivalry, and will fiercely contest his territory with an interloper. In Scotland he is forced to hibernate during a severe winter.

The squirrel usually nests in a tree about a dozen feet or so from the ground. The nest is sphere-shaped and is entered from the side, but squirrel is fastidious, and may build a number before he is satisfied. He is monogamous, and it would seem that he cleaves to his mate for life, although there are exceptions to this, as in human society. The squirrel produces only one litter a year, from three to six young, which set up for themselves, usually at the early age of two months. In size he is on the average from thirteen to fourteen inches, including tail, and changes his russet coat in November.

The hedgehog (*Erinaceus europaeus*) is one of the oldest among British mammals, dating as he does from an early prehistoric period. He is by no means a vegetarian, making his diet from mice, slugs, beetles and insects, some not very savoury, and hunting them by scent like a diminutive hound. He is quick on his feet too, notwithstanding the popular belief that he is a slowcoach, and occasionally follows gutters like the badger, although he is not in the habit of using runways. He has small method in his hunting, chasing his prey from point to point with elaborate carelessness, and devouring it piecemeal as he seeks fresh victims. Snared rabbits are "pie" to the "hotchi-witchi," as the Gipsies call him, and his habit of reclining in warrens frequently means a holocaust among the nestling rabbits. Indeed, hedgehogs have not infrequently decimated a rabbit population in the breeding season. He is also very destructive to game-birds, eating both eggs and fledglings. The rat avoids him like the plague. His spines protect him from falls as well as from enemies, and he can roll down a respectable declivity without risk. Polecats are his worst enemies. By autumn the hedgehog puts on so much flesh that he is forced to hibernate early, and he subsists on his fat during his winter nap, usually taken in a rabbit-warren. The average weight is round about a couple of pounds.

The mole (*Talpa europaea*) which is commercially valuable as the possessor of an enviable coat, is equipped with spade-like feet, naked, pink and powerful. With these splayed shovels and the aid of a gimlet-like proboscis he tunnels underground, and his progress can often actually be noted, so near the surface does he frequently work, poking up the loose earth with his snout, and raising mole-hills. He is by preference a worm-eater, but has also a partiality for slugs and snails. One historian of nature has imagined a mole as large as a bear—a devastating creature indeed, ravenous and insatiable. His tunnel leads to a hole roofed with hard earth and lined with dry grass, from which diverge various bolts and emergency exits.

Volumes could be written about the brown rat (*Mus decumanus*), but here one can but touch on his main peculiarities. Wherever food is the rat is, and there only. From a migratory horde he splits up into communities just large enough to consume such provender as the site may afford. His instincts are well-nigh human, and his destructiveness proverbial, yet the slaughter of him notwithstanding, his powers of reproduction are so extraordinary that all efforts to keep down the rat millions seem hopelessly ineffectual. At the present time he is holding Great Britain to ransom for about £15,000,000 per annum, and it has been estimated that each rat costs the country 7s. 6d. a year! He brings about fifty of his own species into the world annually, and can live for five or six years.

The water-rat or water-vole (*Arvicola amphibius*) is much smaller than the rat, with short, blunt head and fine blue fur. He lives in colonies, like the beaver, but his families retain a large measure of strict privacy. His habits are aquatic and of the daylight, and he is not nearly so prolific as the brown rat. His dwelling is a burrow in the bank of a stream, sometimes more landward in its situation than seems necessary. He is well up in the scale of intelligence, and is certainly not destructive, living almost entirely on willow pith and grass-roots.

The black rat (*Epimys rattus*) was some years ago believed to be extinct, but this type still exists, even in London itself. He is really Asiatic in origin and reached England at some time in the thirteenth century. He is a good deal smaller and more slender than the brown rat, with glossy blue-black fur, hairless ears and pink feet. But he has had to contest every inch of the island with his far stronger and

HEDGEHOG IN A STATE OF DEFENCE AND WHEN HUNTING

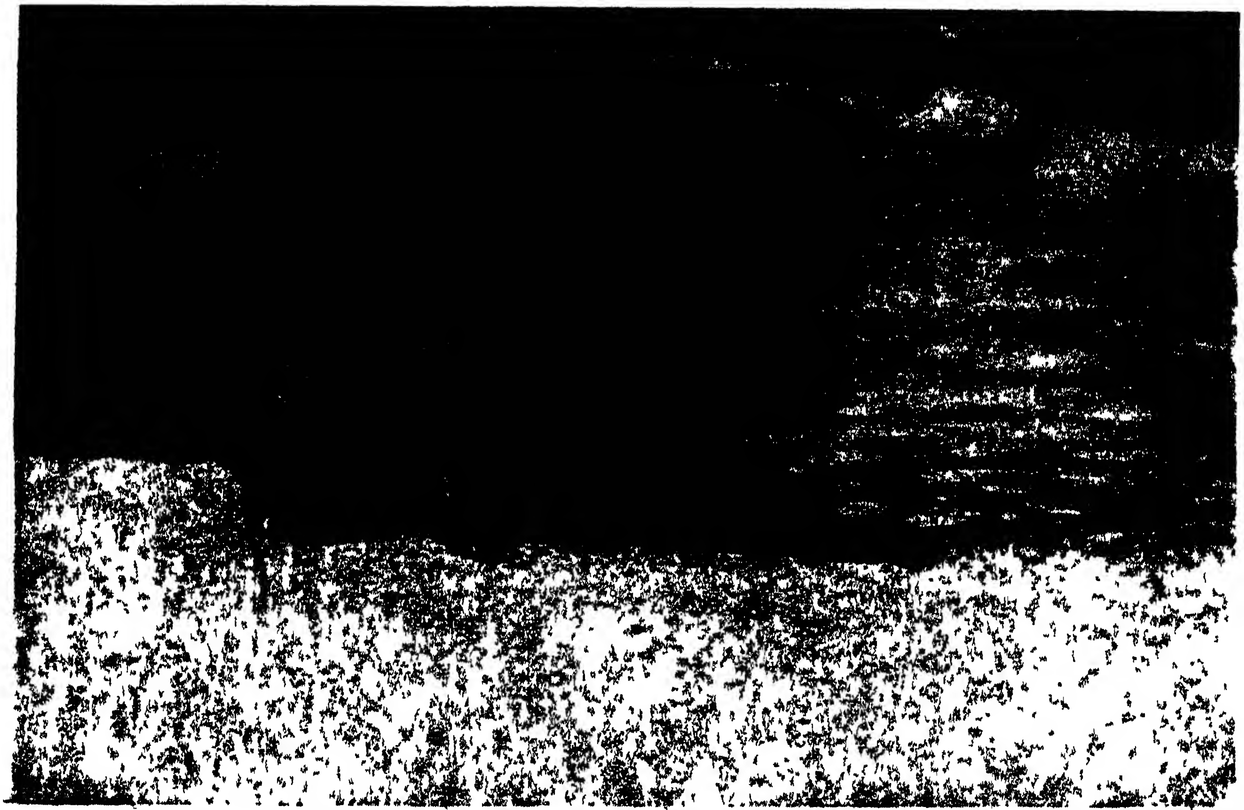
By rolling itself up into a ball so that it presents a bristle of sharp spines on all sides the hedgehog has a most formidable power of passiv resistance. But this is not the only use to which it puts this posture, for, by assuming it, the animal can roll down steep places with impunity It is omnivorous, devouring fruit or beetles or roots or young rabbits with equal enjoyment. It can even cope with, and sometimes kil a viper. In the winter the hedgehog goes to sleep, often in a rabbit warren, living on its own fat.

fiercer brown cousin, who did not invade Britain till the 18th century and who readily devours him.

The common brown mouse (*Mus musculus*) is by far the most familiar and widely distributed of British mammals, and may almost be said to be a particular parasite of humanity. His natural food is grain, but he is really omnivorous. The harvest mouse (*Micromys minutus*) is the smallest of British mammals with the exception of the lesser shrew, measuring just about two inches. His red-yellow coat shades away to white beneath, and his prehensile tail almost serves him as a fifth foot in climbing wheat stalks. His chief habitat is the South of England He will eat insects in the summer, and stores up grain for winter. The harvest mouse lives in a ball-shaped nest suspended above the ground from some hardy weed. The long-tailed field mouse (*Apodemus sylvaticus*) is an inveterate robber of the kitchen garden, and is of nocturnal habits, burrowing underground, where it stores nuts and grain against the winter, at which season, however, it frequently steals into houses. It strongly resembles and is easily confused with the house mouse

The field vole (*Microtus agrestis*) is not closely related to the mouse It has a short stumpy body with blunt head and nose, and reddish-brown fur. It is highly destructive to vegetables and fruit, and although it burrows underground during the winter its tiny summer nest is usually made beside a tuft of grass. The vole is a plague almost as dreaded as the rat by agriculturists and devours new-planted seed and crops with equal impartiality. The bank vole (*Evotomys glareolus*) haunts the hedgerows and wooded country rather than the fields, and is slightly smaller and of a redder hue. It lives on wild roots rather than vegetables or grain.

THE common shrew (*Sorex araneus*) is especially noticeable for his long flexible pointed snout, which makes him look like a dwarf tapir. His food is restricted to small insects, he lives in the fields and is comparatively inoffensive. But he is a dreadful glutton, devouring four times his own weight in thirty-six hours. The lesser shrew (*Sorex minutus*) is hardly to be distinguished from the common variety except in point of size. The water shrew (*Noomys fadiens*) is, however, larger than the common shrew, and its snout is shorter and broader. It is, as the name implies, aquatic in its habits and lives in a burrow on the bank of a brook. The dormouse (*Muscardinus avellanarius*) resembles a tiny squirrel, with its prominent eyes and thickly furred tail. It lives in copses and hedgerows, is nocturnal, and sleeps so soundly by dav that it is often mistaken for dead.



W S Berridge

THE COMMON SEAL THAT HAUNTS THE LONELIER COASTS OF BRITAIN

One species, the common or harbour seal, is native to the coasts of Britain, though several species, including the great grey seal, are not infrequent visitors. The former is from four to five feet long and of a buff-grey colour, and is found off the coasts of Scotland and Wales and also in the Wash and off the north coast of Norfolk. It is disliked intensely by the fishermen for its fish-eating habits, and in the ... It also ascends salmon riv...

Chapter XXX

Survivors of a Lost World: The Giant Iguanas at Home

By T. H. Gillespie

Director, The Scottish Zoological Park, Edinburgh

The largest lizards in the world are the monitors, with the great Komodo monitor at the head of their family. There are, however, no monitors in the New World and their place there is, to a great extent, taken by the Iguanas, a family essentially American, since, of all the numerous species composing it, only two or three are found in the Old World, in Fiji and, curiously enough, in a spot so far from America as Madagascar.

The family, being large, is very varied, and it includes many extremes: species which show the utmost beauty of colouring and grace of form contrasted with those which emphasise the drab and the grotesque; some of the smallest lizard forms and some of the largest. Certainly, when compared with the monitors of Komodo, the size of the largest iguanas may not seem very significant; still, all things are relative, and when judged by the standards of a race in which, for the most part, magnitude is measured by inches and ounces rather than by feet and hundredweights, they attain very respectable dimensions.

The impressiveness of the larger iguanas does not, however, depend entirely on mere weight and measurement but on something more subtle; it is, perhaps, their general appearance and the way in which they recall all that one has imagined of the great and terrible reptiles of the remote past—the "dragons" of the primeval world—that make them seem more thrilling than bodily bulk alone might do. They are, in fact, much more "dragon-like" in form than the monitors. In this respect three or four species stand out from the others. Unlike the monitors, which are carnivorous, the larger iguanas have chosen the most undragonly diet of leaves and fruit, though some of them are not averse to varying it at times with any odd insects, eggs, or small animals that may come their way.

Ewing Galloway

GIANT LIZARD OF THE SEA

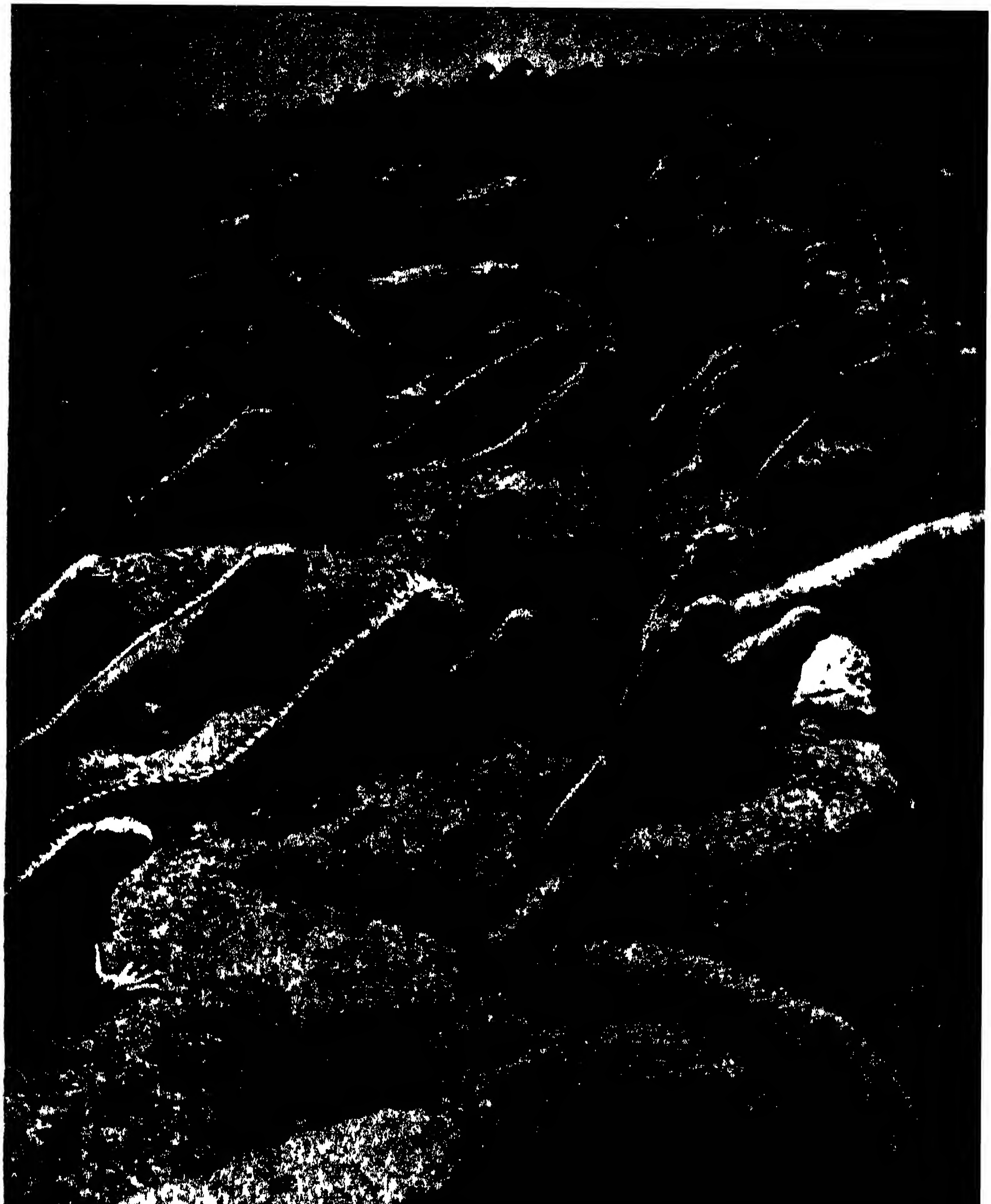
Largest of its family, the giant sea iguana of the lonely Galapagos Islands is a fine-looking monster, and of a mild and equable temperament. The specimen seen above was nearly five feet long, about the greatest length that is attained by these huge lizards.

In the Galapagos Islands, where the youth of the world seems to have lingered and the dominant animal forms are reptilian, is the home of the first of these iguanas, one of the most remarkable of living lizards It is known, technically, as *Amblyrhinchus cristatus*, and it has the distinction of being the largest member of its family and the largest of American lizards. It has, moreover, a further and more outstanding character, for it is, so far as is known, the only lizard in the world which has taken to the sea for its living, and spends much of its life and finds all its food there. It is therefore most aptly called the marine iguana.

When one remembers how many land animals have sought their solution of the problem of finding food in a return to the sea it seems the more remarkable that only one of the many hundreds of lizards should have done so. Early observers who had seen marine iguanas swimming out to sea concluded that they were going in pursuit of fish; that was an error, however, for they are entirely vegetable feeders and live solely on seaweeds.

It was Darwin who, in "A Naturalist's Voyage Round the World," first described at length the appearance and habits of the sea iguana, and recently Mr. William Beebe, Director of the New York Zoological Society's Tropical Research Department, has added to the earlier information not only much very vivid and picturesque detail but also a wonderful series of photographs of this lizard at home.

The marine iguana attains a length of upwards of four feet. Mere length is, however, no criterion of



A MULTITUDE OF MARINE IGUANAS ON THE LAVA ROCKS OF GALAPAGO

Among the lava rocks of the volcanic islands which are their home the marine iguanas seem an inseparable part of the landsca Their shape and their colour blend completely with their surroundings where the surf of the vast Pacific beats for ever against th islands, which are mountain tops thrust out of the ocean This wonderful photograph was taken on Narborough Island at beginning of this century, and is a precious record of a state of things which is ending. No such vast hordes exist now, for iguanas are slowly dying out They have already outlived their age-long day.

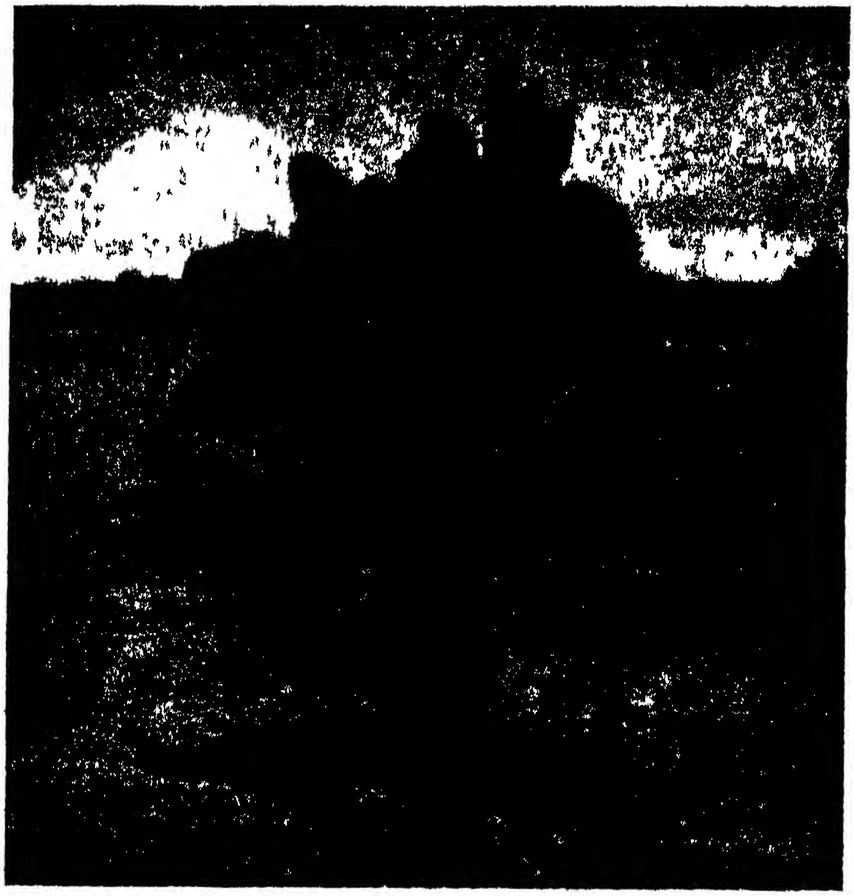
M Wili am Be b C pyi

IVALS FROM A PREHISTORIC AGE IN A LOST WORLD OF THE PACIFIC

iysterv of the iguanas of Galapagos is one with the puzzle of the archipelago itself Were these islands uplifted, one by one, by volcanic from the ocean bed, were they originally one island which has become split up; or were they a part of a now submerged portion of America? The iguanas, in any case, have managed to evade the remorseless process of time which exterminated the giant saurians

iotograph, with those on page 314, and facing page 330 are from "Galapagos World's End" by courtesy of the author, Mr William Beebe of the New York Zoological Society, and of the Publishers, Messrs G P. Putnam's Sons

a lizard's size; for example, the tuberculated iguana grows to six feet long, though more than two-thirds of that is tail, and it is slender and not to be in bulk with its marine relative which is of heavy, massive build. As might be expected in a lizard which spends much time in the water, the tail is flattened sideways for swimming and the lizards swim with ease and speed by the movement of the



tail, after the manner of an eel. The seaweeds which they eat grow in fairly deep water and although, when they can do so, the iguanas get as much of their food as possible when the tide is low, they must often have to go beneath the surface to feed. It is to be expected, therefore, that this lizard can remain under water for a fairly long period without coming up for air, but its capacity in that matter rather exceeds expectation. Darwin mentions that one of the seamen on the "Beagle," wishing to kill one of these lizards that he had captured, and thinking, perhaps, that drowning was the readiest method, tied a heavy weight to it and sank it in deep water. He let it remain there for an hour but when, at the end of that time, he pulled it up the lizard was as lively as ever, a toleration of submergence which one exposed to the risks of the sea might well envy.

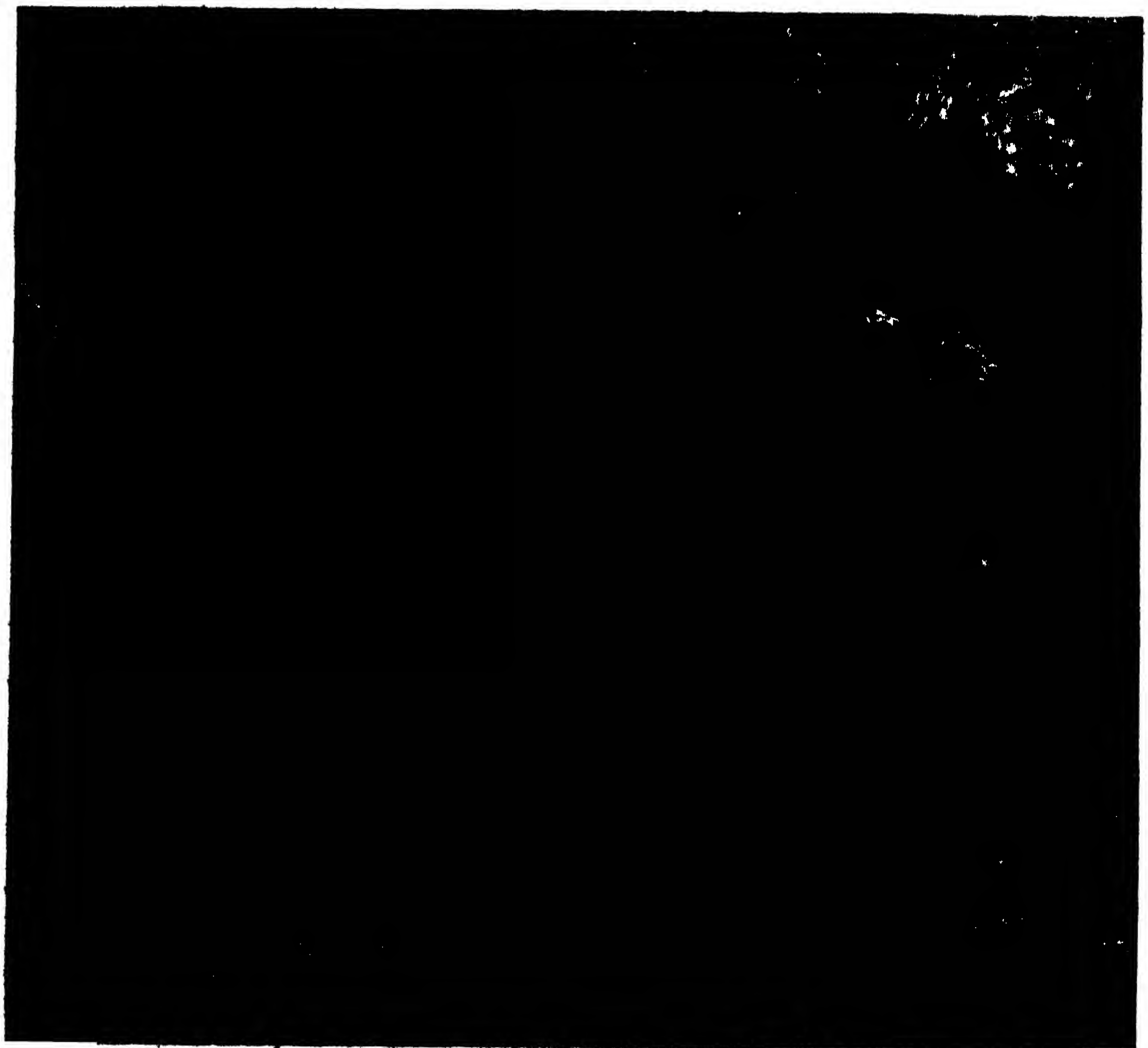
While this lizard feeds in the sea, it seeks shelter and sanctuary on the shore, and if it is ashore nothing [illegible] when one of [illegible] returned at once to the [illegible] and this it did repeatedly. Darwin [illegible] explanation of this curious habit, that the [illegible] has no enemies whatever on shore, man being too recent to have had any influence on its racial behaviour, but at sea it must often fall a prey to the numerous sharks; its hereditary instinct is, therefore, to regard the shore as offering safety, no matter whence the alarm may have come. It has, moreover, a very remarkable sense of direction, as Mr. Beebe found when he threw one into the water two miles from land. Although the land must have been quite invisible to the lizard, it swam round the ship and immediately headed straight for the shore.

It is when it is ashore that the marine iguana is most impressive. "As black and rugged as the lava boulders themselves," says Mr. Beebe, "these splendid saurians crept about like great prehistoric monsters. No other living inhabitant of these islands seemed so thoroughly a part of its environment. In colour, in rough contour, in the scales of its head standing up like volcanic cones, in its intimacy with lava and surf, it seemed an organic embodiment of the shores of these desolate islands

Mr Wm. Beebe, Copyright

FIERCE LAND IGUANA

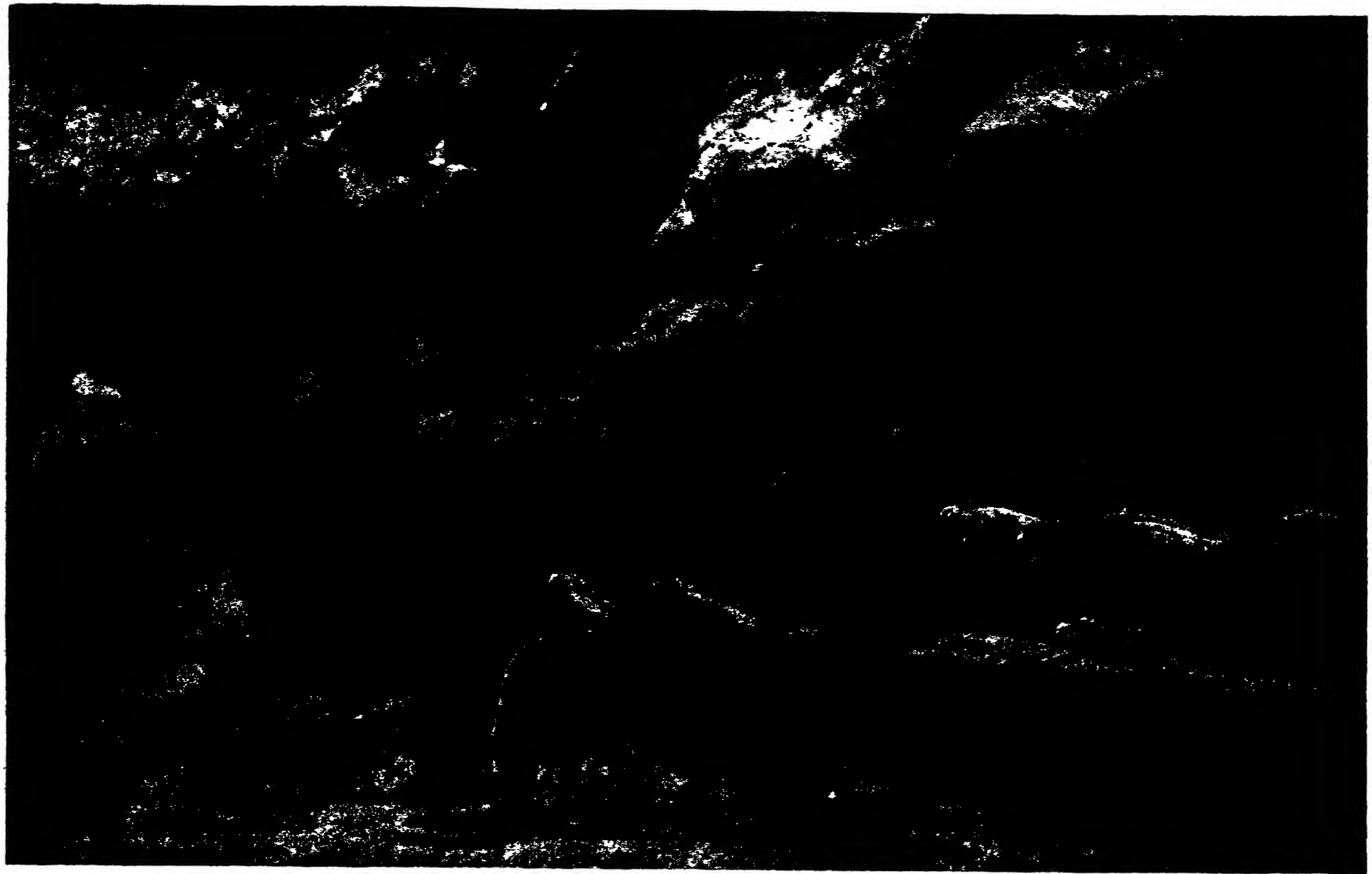
The land iguanas of Galapagos differ from their sea cousins in colour and character—orange and red brown instead of black, and fierce instead of gentle. By day they lie beneath the cactus plants (top), following the shadow as it moves.



Dr G. Kingsley Noble

WHERE THE RHINOCEROS IGUANA OF HAITI HAS ITS HOME AND LAYS ITS EGGS

A particularly imposing iguana is found on two islands of the West Indies, Haiti and Porto Rico, and nowhere else. It lives in burrows (bottom) which it can drive through limestone sometimes for a distance of forty feet. Here we see a bank of fossil corals tunnelled for a home. The eggs are laid a few feet below the surface of the sand. The top photographs show (left) the site of a clutch and (right) a nest being brought to light. The eggs are rather larger than a chicken's but the shells are leathery.



MARINE IGUANAS COME TO INSPECT MEMBERS OF THE EXPEDITION TO THE GALAPAGOS ISLANDS

When American explorers visited the Galapagos Archipelago to inspect the giant iguanas, described by Darwin in his account of his famous voyage in the "Beagle," some of the iguanas of Albemarle Island turned out to examine the explorers As we see here a number of younger beasts crawled along the rocks quite close to the strange invader, man. It seems as though the Galapagos Islands, which lie in the Pacific 695 miles west of the Ecuador coast of South America, had been left behind in the history of the world. The strange creatures which inhabit them are strongly reminiscent of the prehistoric monsters whose appearance scientists have reconstructed from their fossil remains in other parts of the world.

It lies on shore sunning itself by day and at night, or when alarmed, takes refuge in crevices or holes in the rocks. If the hole should be too small to accommodate the entire lizard and a hold can be got on its tail, it may be pulled out, but only after a great struggle, for it not only clings to its refuge with its strong claws but also puffs out its body so that the rough scales help to grip the sides of the crevice. One might expect that when the iguana was pulled out it would emerge in a particularly nasty temper, and that having such powerful jaws and claws it would use them with due effect. On the contrary, it is a most gentle and docile " dragon " and cannot be induced, either by sudden fright or by prolonged teasing, to bite.

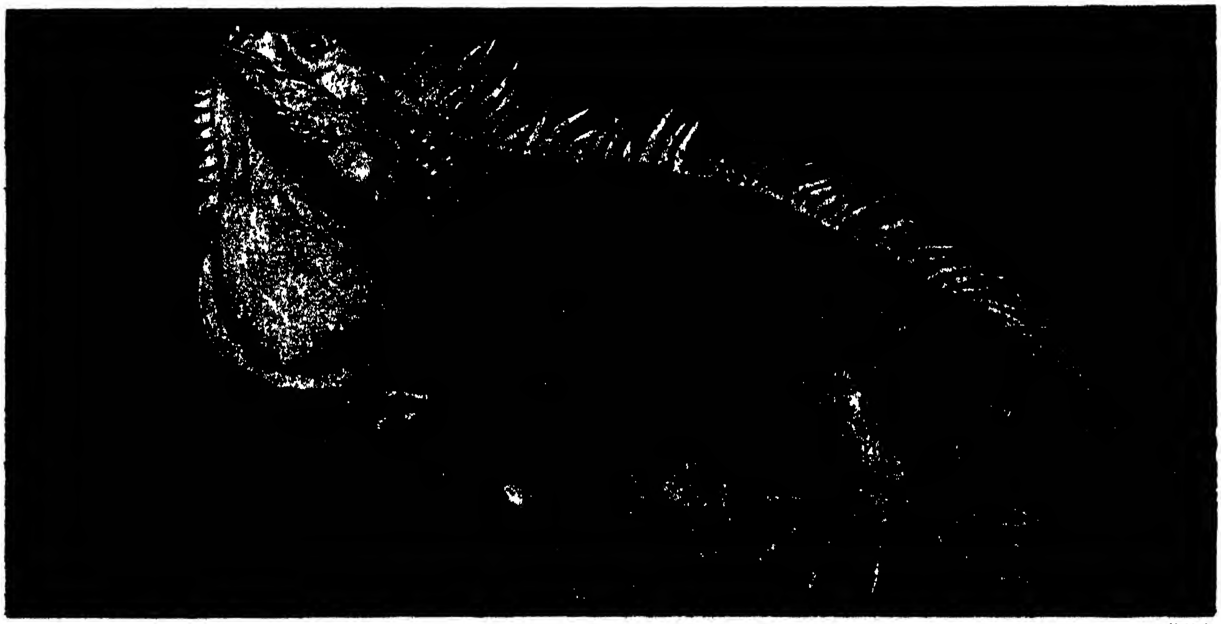
WHILE the marine iguana is still very numerous, Mr. Beebe states that the vast hordes which might be seen some twenty-five years ago no longer exist, and he is of opinion that they are slowly but certainly decreasing. It is unlikely that this fine lizard will ever be seen in any zoological park or garden in Europe (though it has been exhibited for a short period in New York), for when captured it cannot be persuaded to feed. It can, like many reptiles, fast for a prolonged period without losing strength and Mr. Beebe was able to bring some home alive. " From one thousand miles out in the Pacific to New York, and for two months later, these lizards lived and apparently thrived on salt water and air. No variety of seaweed or terrestrial vegetable tempted them to break their fast." After one hundred days of complete abstinence from food they " appeared as active and as strong as when first taken from among their native lava."

The domain of the sea iguana stops with the shore, and inland, on some of the islands, its place is taken by a land iguana only a little less in length and not dissimilar in shape but quite different in colour and character. Instead of the sober blackish colour of the former the inland species is orange or yellow on the head and forelegs, paler yellow below, and reddish brown on the back, a fairly striking combination. In temper it is described by Beebe as being irritable and fierce, and willing, when captured, to do its best with tooth and claw to regain its freedom.

DARWIN'S judgement was kinder; "they try to look very fierce," he says, " but in reality they are not at all so," and he adds that " if held and plagued with a stick it will bite very severely, but I caught many by the tail and they never tried to bite me." Darwin gives an amusing account of this iguana's method of burrowing:

> This animal, when making its burrow, works alternately the opposite sides of its body. One front leg for a short time scratches up the soil and throws it towards the hind foot which is well placed so as to heave it beyond the mouth of the hole. That side of the body being tired, the other takes up the task and so on alternately. I watched one for a long time till half its body was buried; I then walked up and pulled it by the tail; at this it was greatly astonished and shuffled up to see what was the matter; and then stared me in the face as much as to say, ' What made you pull my tail ? '

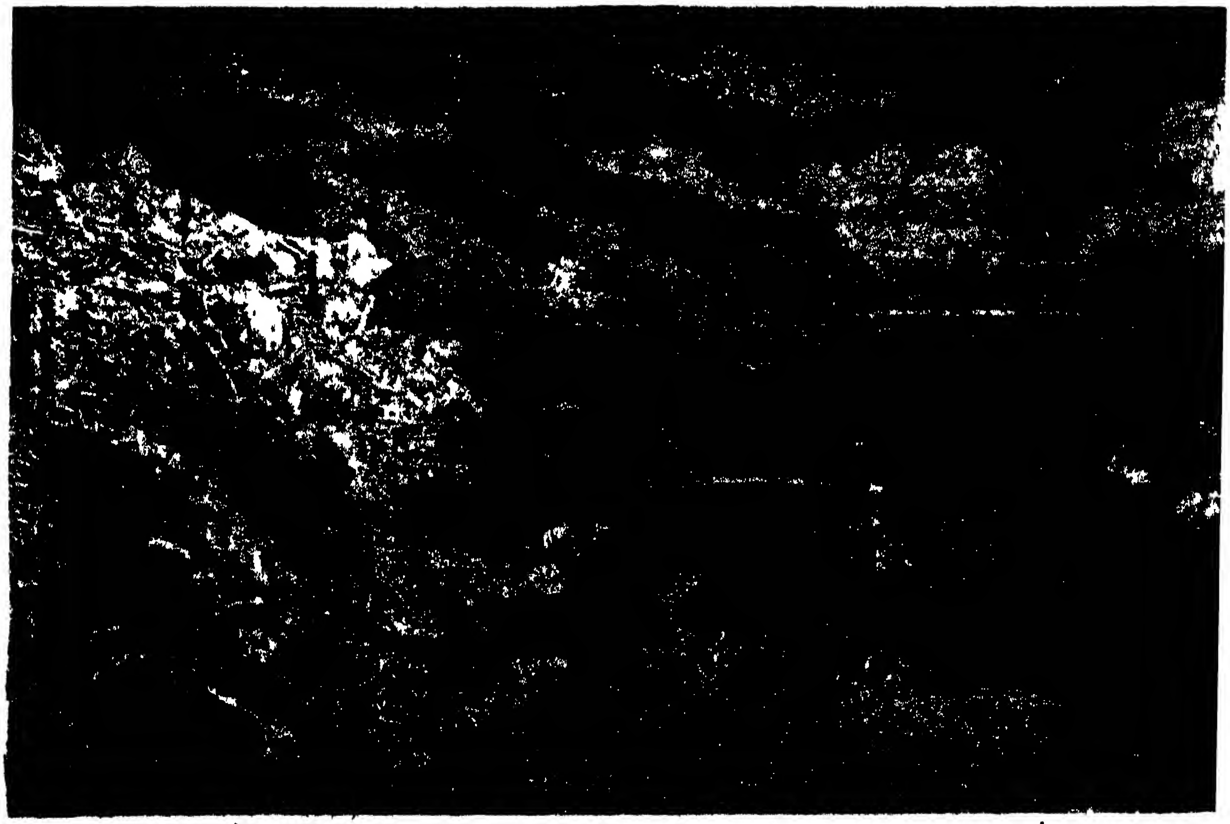
At the time of his visit these iguanas were so numerous that " we could not for some time find a spot free from their burrows on which to pitch our single



E.N.A.

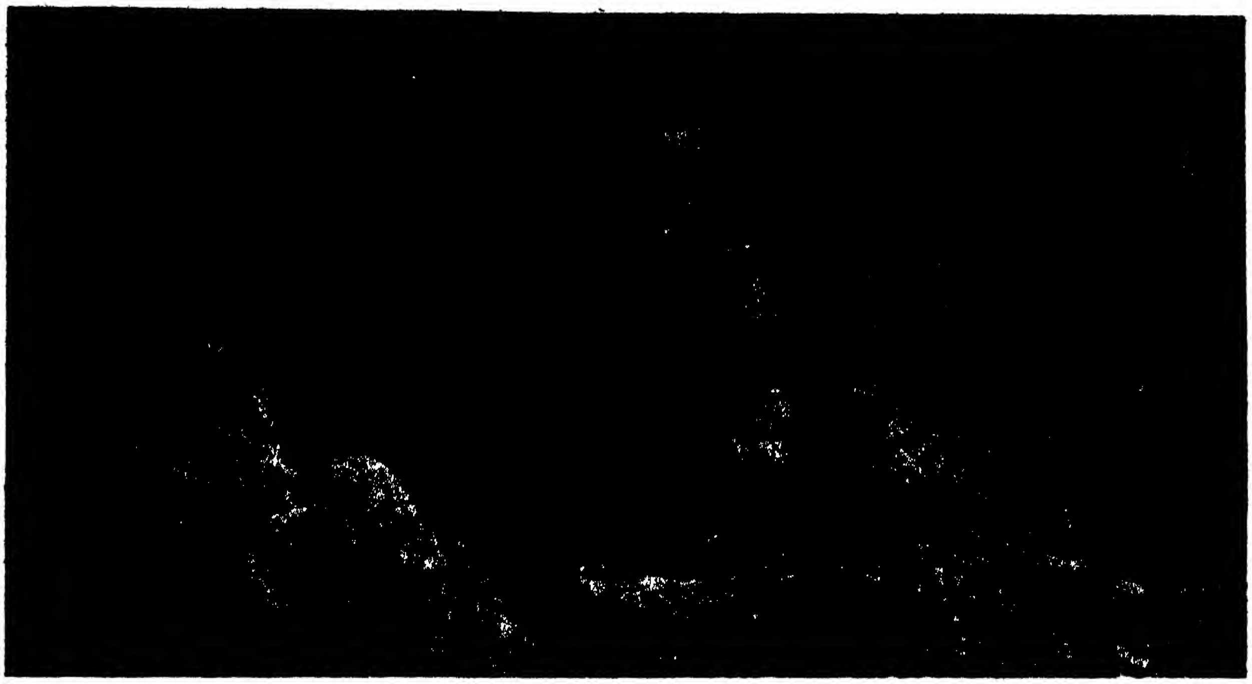
' LIKE SOME PREHISTORIC MONSTER: IGUANA OF CENTRAL AMERICA

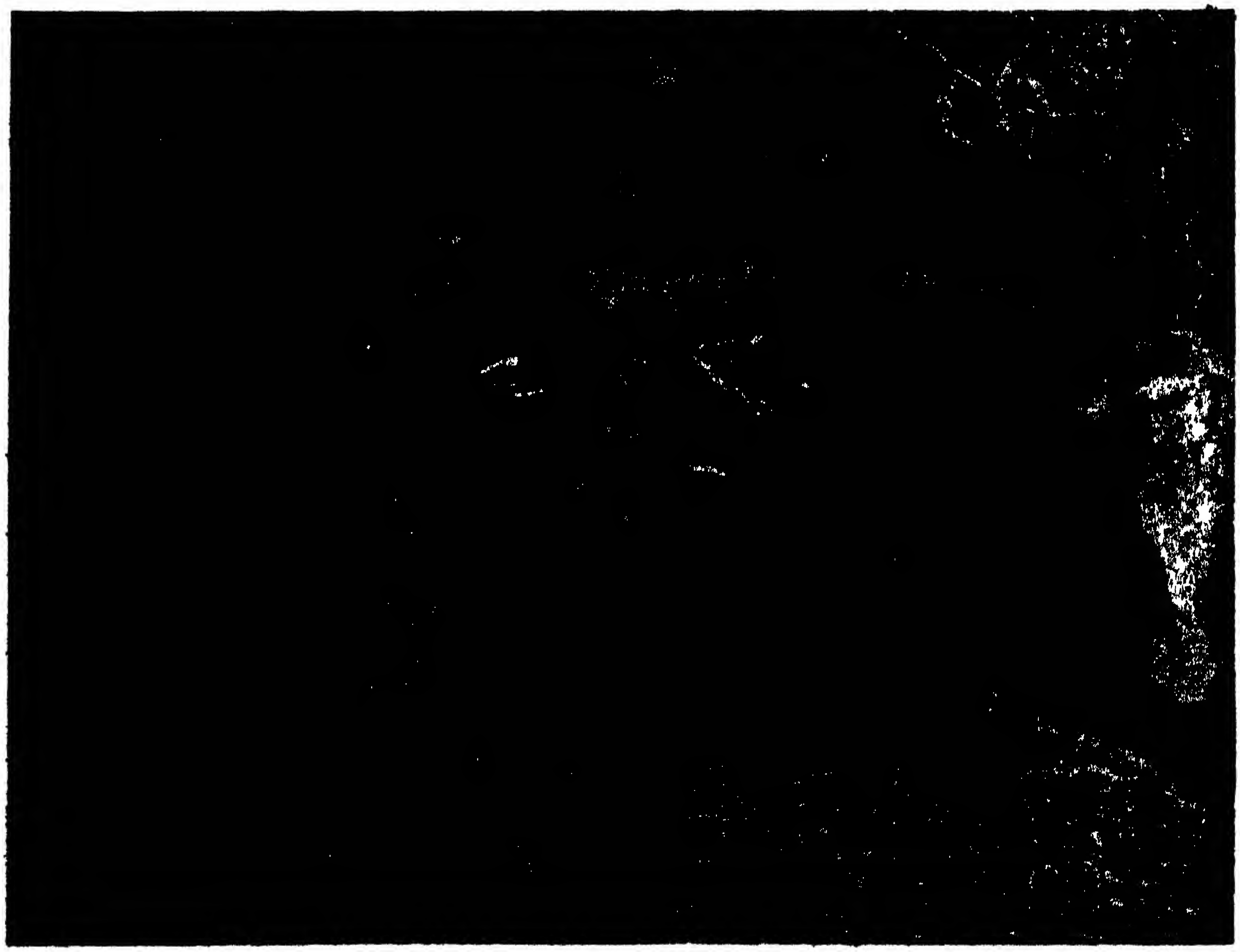
This iguana might well be used as an illustration of a dragon for some romance of chivalry and is not unlike some of the gigantic saurians that possessed the earth before man became its master. In reality it is an inhabitant of Central America, living among the trees of the tropical forests usually in proximity to water. It is an expert climber and its diet consists largely of berries and leaves varied by insects. The great dewlap and the spines on the back are characteristic of the species.



RHINOCEROS IGUANAS AS THEY LIVE BESIDE A LAKE OF HAITI

By the waters of Lake Enriquillo on the island of Haiti live numbers of the rhinoceros iguanas, so named from the horns upon their wicked-looking snouts. When the sun is at its hottest the great lizards come out of their burrows in the coral and the observer may witness a scene such as that shown in the lower illustration. The upper photograph shows some young iguanas hatching out of their eggs in the sand. These photographs and those on pages 315, 319 and 320 are by Dr. G. Kingsley Noble of the American Museum of Natural History.





GAPING JAWS AND CRESTED SPINE OF THE RHINOCEROS IGUANA

These two illustrations are enlarged portions of the lower photograph in the opposite page, showing, at close range, the physique and mien of the full-grown rhinoceros iguana of the West Indies. The lower photograph here enables us to see the wide-gaping jaws of a creature which, unlike the mild-tempered marine iguana of Galapagos, is ready and willing to inflict a terrible bite upon man or animal that attacks it. But unprovoked the iguana is harmless enough. The upper photograph depicts one of the creatures just emerging from its burrow.

Dr G. Kingsley Noble

DOMINICAN SPIKE-TAILED IGUANA

In the island of Santo Domingo there is a salt lake called Enriquillo, and in the middle of it an island. When this island was explored a kind of iguana was found among the cactus bushes there which differed from the rhinoceros iguanas of the mountains about the lake in that it had no horn upon its head, but instead was armed with a strongly spiked tail.

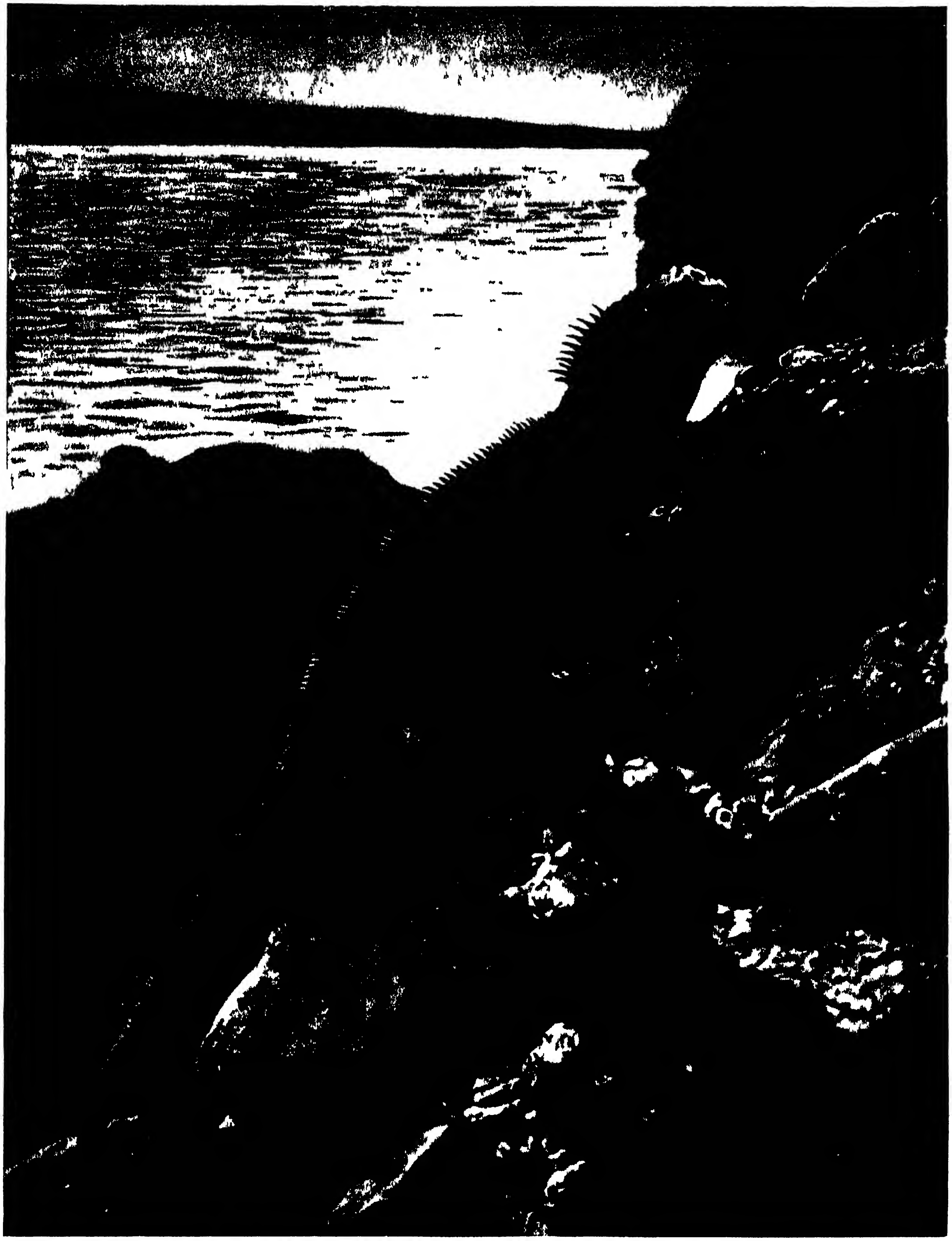
tent." In another matter, too, the Galapagos land iguana differs from its marine brother; it is quite ready to feed in captivity and meets the change from cactus to cabbage in an accommodating spirit, so Mr. Beebe was able to take home a number which lived and thrived in the Reptile House in the New York Zoological Park.

Most showy and most interesting, in the writer's opinion, of all the iguanas is the great horned or rhinoceros iguana (*Cyclura cornuta*) whose home is also confined to two islands, namely, Hayti (or San Domingo) and Porto Rico in the West Indies. This lizard, dark greyish-black in colour, of massive build, with large head and wide jaws, a hanging throat pouch, loose wrinkled skin, and the crest of spines—characteristic of all these iguanas—on its back, seems perfectly modelled to suggest the gigantic reptiles of the past. It receives its popular name from three not very large, blunt "horns" on its nose.

Though it thrives in captivity, this lizard is difficult to obtain. Not only has it a very restricted range but, though fairly numerous in the localities in which it is found, it is not easy to capture it uninjured. With its strong forelegs and claws it is able to burrow deeply, even into the limestone, where burrows as much as forty feet long have been found, and when hunted with dogs (which are specially trained for the purpose) it will not hesitate to turn on these animals.

It is said to be extremely vicious, and when being hunted, or when newly captured, it may well be so, but it can be easily tamed and the single specimen the writer has possessed, a half-grown one, was quite gentle. It would lie contentedly on one's forearm for so long as one cared to bear its not negligible weight, and it seemed to enjoy having the skin of its throat rubbed and scratched. Bananas were its regular and perhaps favourite food, but it would accept a dead mouse promptly; in that it exemplified the recorded habits of its species which is described as being much more carnivorous than most of the large iguanas.

One cannot, of course, judge the behaviour of any wild animal from that of specimens which, in the case of iguanas, have spent weeks in travelling in cramped boxes, with frequent handling, before one sees them, but the writer's experience inclines him strongly to question the appropriateness of such terms as ferocious and vicious in relation to the big iguanas; a reasonable degree of self-defence, which is, after all, a very deep-seated instinct in all kinds of wild animals, being allowed a nervous animal. Those that will live in captivity seem as engaging in disposition as they are interesting in habit and impressive in appearance. Unfortunately, though, many of them have something of the quality of Moore's gazelle!



GREAT MARINE IGUANA OF THE GALAPAGOS ISLANDS

By day the marine iguanas of the Galapagos Islands, which are like a lost world in the Pacific, bask upon the baking rocks of lava by the shore. At night they sleep in some crevice. They wait until the tide is low and then go in search of the seaweeds which are their food, but often they have to swim out to sea to get a meal. Ashore the marine iguanas have for ages had no enemies and they always make for the land when alarmed.

To face page 320

Chapter XXXI

The Fighting Instinct in Animal Life

By A. D. Peacock

Professor of Natural History, University College, Dundee

If the question were asked, "What is Darwin's greatest book?" the answer would be "The Origin of Species"; a naturalist, with scientific licence, might even say briefly "The Origin." But this title is really not enough, for it is too little recognized that the alternative title, The Preservation of Favoured Races in the Struggle for Life, is of the utmost importance in appreciating the master's point of view and line of argument. This article deals with a special and restricted phase of that great hard fact of the struggle in animated nature, not for life, for that has a wide range of meaning, but for the barest necessaries of existence. We are to consider the rôle of force among animals.

The grim instinct of fighting is exercised under four main sets of circumstances, namely, the struggle for individual subsistence, courtship competition, the fight for the family, and the fight for the race. The struggle of the individual centres round the necessity for food and shelter, and in the apostles of brute force they are sought by offensive and predatory methods. These methods may be used by animals against their own kind, as when dogs fight over a bone, or when parent birds drive away their own offspring, or when a lion brings down a deer and is prepared to hold its kill against all comers. Even foothold must be fought for sometimes, and this is well shown on the sea-board among the crowded cliff residents such as razor-bills.

Though it is very far from being a general rule that the mated female spider devours its male partner (see Savoury's The Biology of Spiders) there is no doubt that ferocious cannibalism exists. The common garden spider (*Epeira diademata*) is one of such habit. Hunger is the mainspring. The eating of the male has nothing to do with the pairing instinct; it is an unfortunate accident, most probably brought about by the inability of the male to escape owing to weakness after pairing. Any other spider near a hungry female, whether mated or not, runs the same risk.

Keystone

SAVAGE SNOW LEOPARD

Leopards are among the fiercest of that fierce family of animals, the great cats, and the snow leopard from Siberia is no exception. When irritated to fighting pitch the animal takes a great deal of stopping and backs its savage snarls with its equally savage claws.

Fighting for shelter may also occur between animals of the same kind, and a good example of this is seen in the hermit crabs (*Eupagurus bernhardus*). Shelter with them is no mere temporary matter, but a vital necessity, for the hind body is a soft, curled, deformed and degenerate part which must be artificially protected within a hard molluscan shell. Growth necessitates a shifting to larger quarters and should a large enough shell be unavailable the homeless crab will attack a more fortunate fellow in its castle.

Ironically enough a wicked pusillanimity, not reaching however to actual mortal fighting, is found not among the beasts of prey but among the vegetarians. The Indian flying-foxes (*Pteropus medius*) live gregariously "as thick as bees," but it is each one for itself as far as food and foothold are concerned. Social harmony seems to reign only during sleep. The fruits collected by each are those of discord; each loves a place in the shadow; and, to get these, their home in the trees is a confusion of noise and violent fighting, the weapons being the teeth and the nasty hooked claw of the thumb.

In the proverbial sayings concerning the "turning of the worm" and "when the sheep rebel," and in the famous but unconscious humour of the French natural historian who naïvely stated, "This animal is dangerous, it defends itself when attacked," we see a great truth—the fighting instinct is present in most animals and, though it may slumber in the meek, it can be

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roused and exercised if the straits are dire enough.

Of a different order, but still compact of the same stuff as the instinct to fight, is the type of " hen-pecking " which determines the order of precedence of fowls in their run, or sparrows and wild ducks in their flocks. Curiously enough, it seems established for fowls that the leader in precedence, who has fought his or her way to the head, is likewise the most intelligent. Whatever there may be of *liberté* or *fraternité* there is little *égalité*. The curious will find much of interest in these matters in Alverdes' "Social Life in the Animal World."

British Instructional Films

FIGHTING FEMALES OF THE MANTIS, AND THE DEADLY SCORPION

The females of the insect called the praying mantis, so soon as mating is accomplished, at once proceed to eat their mates. The females fight furiously, as we see above, for the wretched creature who provides not only the wedding, but the wedding breakfast. The scorpion (top) assumes this posture of defence in a trice and is one of the deadliest insects.

THAT the path of true love is not smooth is nowhere better shown than in the courting days of very many animals, though, strangely enough, most of the animals that indulge in terrific struggles are not of the assertive and pugnacious orders. Rather they are of the shyer, gentler and elegant breeds, which find safety in numbers and are fond of each other's company. Discord comes and lasts only for a particular season of short duration. One of the most famous examples is, of course, the deer.

For the winter months, November to March, the red deer live in herds, both hinds and antlered stags, in perfect amity. But from March to July the stags lead solitary inoffensive lives, what time the antlers are shed and re-grown. By October the long antlers are hardened and insensitive, the velvet covering that produced and nourished them is shed, the neck swells and is more richly maned, and the stags forsake their solitude with a more gifted voice of wonderful range and timbre that serves at once for an imperious love call to the hinds and a bold challenge to rivals. Each forms a harem, or adopts one already banded, but at the cost of many furious battles. Though the antlers are armament, and engage when the stags meet head to head, they do not decide the issue either by inflicting serious wounds or the " coup de grâce," for the knightly tournament is really one of pushing. Even a bald stag may win. Fatalities are rare, perhaps one per cent, and are usually due to interlocking and hold-fast of antlers, and consequent bodily exhaustion. The fighting instinct being part and parcel of the inspirations of love and jealousy, these conflicts ensue year after year, the weaker being denied the ability to engender offspring after its kind and so lower the efficiency of the race, the stronger giving of its vigorous gifts to the benefit of the generations that are to come.

Similar stories can be told of other deer, such as the wapiti and moose, but in their distant relatives, the antelopes, the fights may be to the death.

Of other herding animals—guanacos, vicunas and the feral horses of South America, the zebras and Nubian wild asses of Africa and the kangaroos of Australia—the same general features are seen, namely, the single dominant male, jealous of rivals and willing to fight the herd enemies.

AMONG European bison the old bulls lead solitary lives and are usually a match for the wolves. But in the rutting season they join the herd and their fighting qualities are used in battling for mates. The ferocity and altruism of the American bison on behalf of the herd are believed now to have been overstated. A curious modification of rutting behaviour is seen in other bovines, such as the South African gnu and the Burmese banteng, where the young bulls league together to drive out the old steers.

Even in aquatic mammals the bulls of the fur seals (*Callorhinus*) fight furiously on the breeding shores to establish and maintain their harems until the friendly sea life once again is resumed.

Turning to the birds we find that the male eagles and capercailzies fight over their mates; but a curious reversion is witnessed in the button quails (*Turnices*) and phalaropes, for their females are the larger, are more gaily feathered and dispute for the males which subsequently rear the brood.

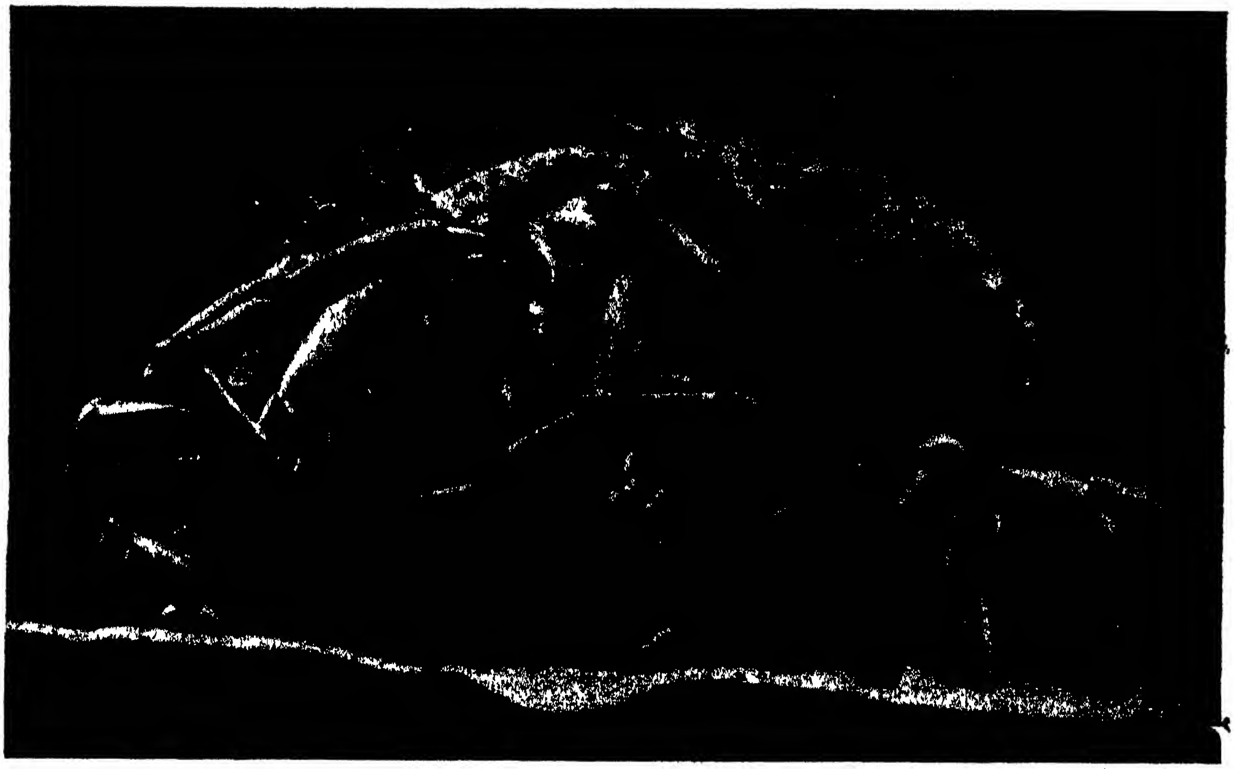
The reptiles likewise have their duels, examples being male crocodiles, Malayan lizards, which change their colour as they fight, and the Carolina iguana (*Anolis carolinensis*) where the loser forfeits his tail and the victor eats it. Omitting the amphibia, which offer little of interest in this regard, and the fishes and other aquatic animals, which are treated specially elsewhere, there is little of remark until we reach the insects, where males of the long-horned grasshoppers, the stag beetles, ground wasps and solitary bees may contend to the death.

Touching the fight for the family we cannot do better than consider briefly one of its phases through the medium of Howard's remarkable book on

A. E. Smith

TO THE DEATH: DESPERATE DUEL BETWEEN TWO WOOD ANTS

Upon walking through a pine wood, one may often see the large mounds of pine needles which form the nests of the wood ants. A close inspection of the ground in the vicinity will often reveal a tremendous activity going on, workers returning with some captured insect, or bringing in more pine needles. But the ants are warriors as well as workers, and a meeting between members of rival communities will lead to a struggle whose only end is death. Here we see (greatly magnified) a couple of these small creatures furiously biting each other.



Neville Kingston

SPIDER CRABS AT DEATH GRIPS UNDER WATER

To test the fighting instinct of the crab it is only necessary to get within reach of its formidable claws. The larger crabs, when stranded in some cranny in the rocks by the departing tide, have also an ugly trick of rising up on their legs from a crouching position, and bearing with their backs against the roof of their retreat, effectually trapping the incautious hand that has alarmed them. This remarkable photograph shows a pair of spider crabs in the act of fighting fiercely under water.

"Territory in Bird Life," a work of unusual merit in the annals of bird-lore and animal behaviour. Its thesis is that, in very many birds, "each male isolates itself at the commencement of the breeding season and exercises dominion over a restricted area of ground." There are internecine struggles between the males of blackbirds, lapwings, cuckoos, pied wagtails, long-tailed tits and jays, and inter-specific battles between peregrine falcon and raven and between the green woodpeckers and the great spotted woodpeckers.

Other workers have shown that moor-hens, coots, swans, wild ducks and wild geese, defend their area and nest against their kind. Not unexpectedly, the quaint penguins add to their quaintness in breeding time by having regular beats around their rectangular stony patches. In those birds of prey, the falcons and eagles, both mates defend their family and their far-flung quartering ground against intruders, and in the case of a South African eagle (*Haliaetus vocifer*) the range extends to a diameter of two miles. Among mammals the same is illustrated by apes and kangaroos, though here it may be that the fighting is on behalf of not only the family but the herd. The leaders of separate hordes of Indian macaque monkeys fight duels and sometimes thereby provoke a general embroilment. And oriental travellers tell us that "pi-dogs" have their own special low alley haunts, in which a strange dog will be torn to bits. Despite its size we may regard the bee-hive population as one big family and the killing of all strangers at the door as a protective exercise of the fighting instinct. We need not repeat the many prodigies of valour that are performed by mothers in defence of their young—even as the hen defends her chickens—not only against enemies, but, as in the case of beasts of prey, against infanticidal fathers. Fathers, too, may back the protective instinct by fighting, as witness the dog fox in defence of the litter.

The mid-wife toad (*Alytes obstetricans*) also deserves a word. It may more truly be called a "mid-man," for it is the husband that will fight marauders for the string of eggs that encumbers his legs.

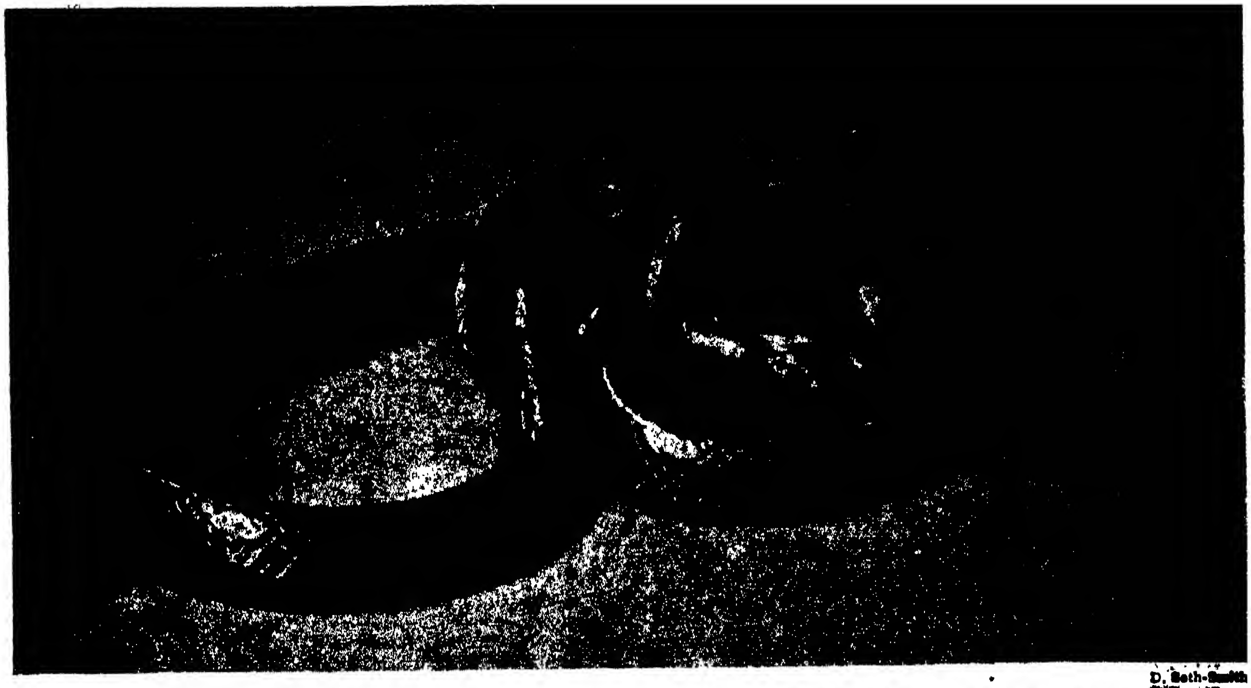
A curious situation arises at nesting-time among the ostriches, where the male arranges the nest and where females are in the majority. Surplus hens, though they may pair, lay their eggs beside those of other birds which have a consort. This leads to fighting between the hens and a tragic smashing of eggs.

But, always excepting man, it is of those Lilliputians the insects that the greatest fighting epics must be written. The stories centre round social types such as the termites and ants which form colonies. In most cases each colony is a single family founded by a mother-queen, and for this reason their fighting behaviour is discussed under the present head. It should be remembered, however, that colonies may

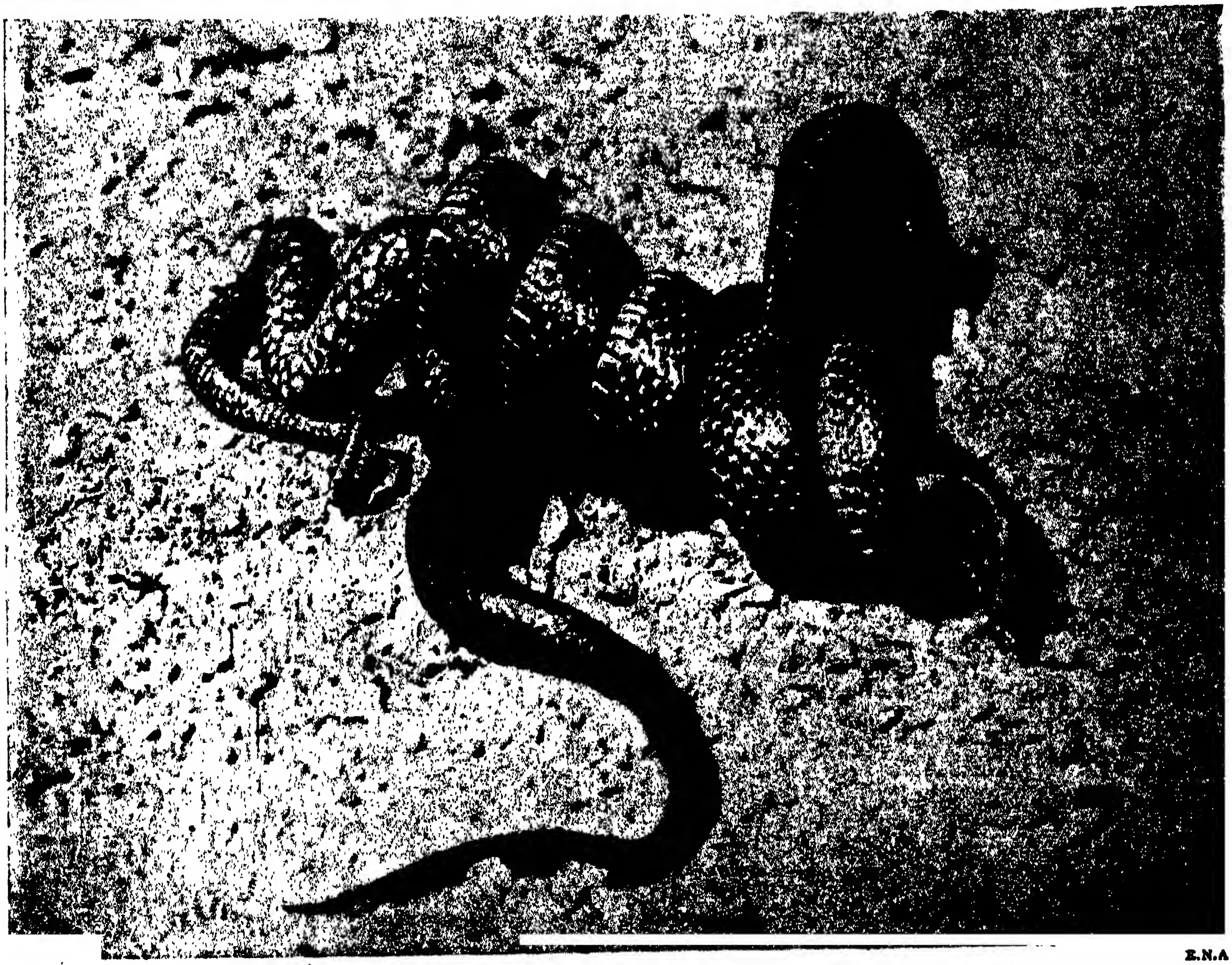
Central Press

FIGHTING INSTINCT AS IT IS EXPRESSED BY THE LAND CRABS

Even in what must be an alarming situation to it, suspension in mid-air, the land crab (bottom) does not cease to grip with powerful claw the clumsy boot that has intruded upon its peace. The fighting land crabs of Gambia (top), the British colony in West Africa, have not earned their name for nothing. When in captivity missing limbs about their place of confinement give evidence of the frequent battles which these fierce creatures wage with each other. Luckily such lost limbs are replaceable.



D. Seth-Smith



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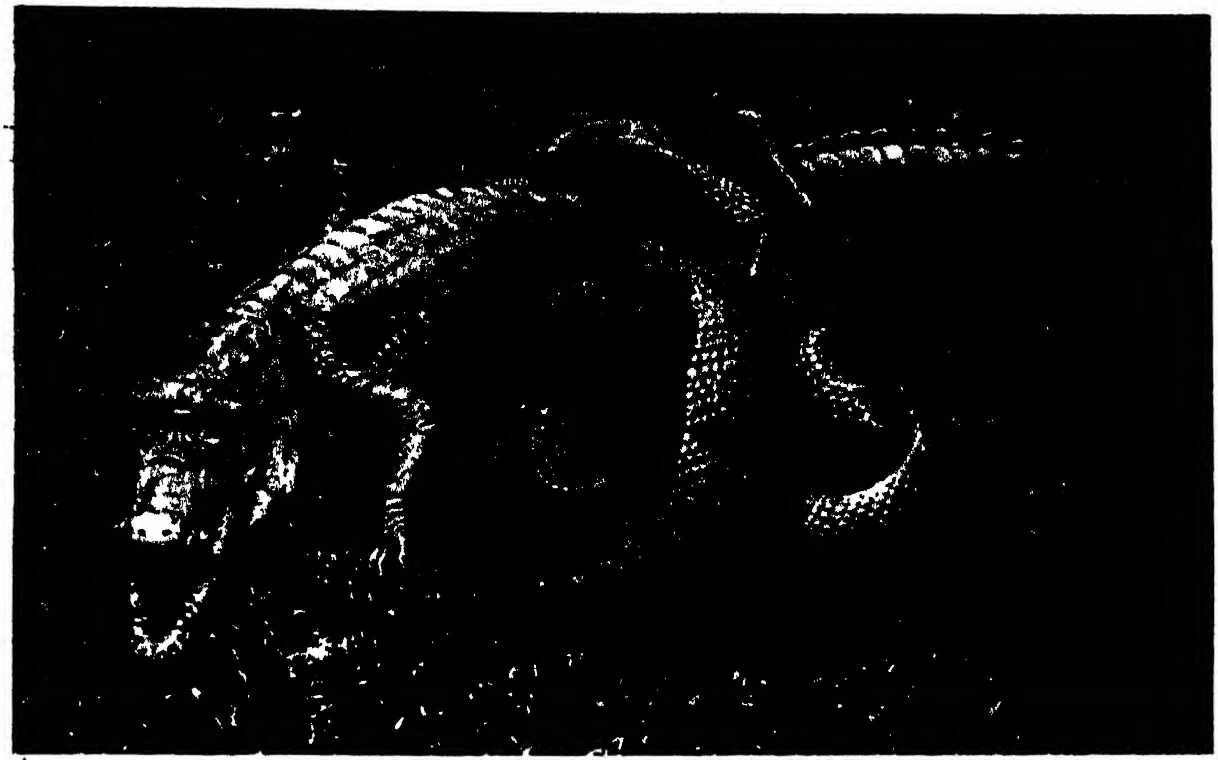
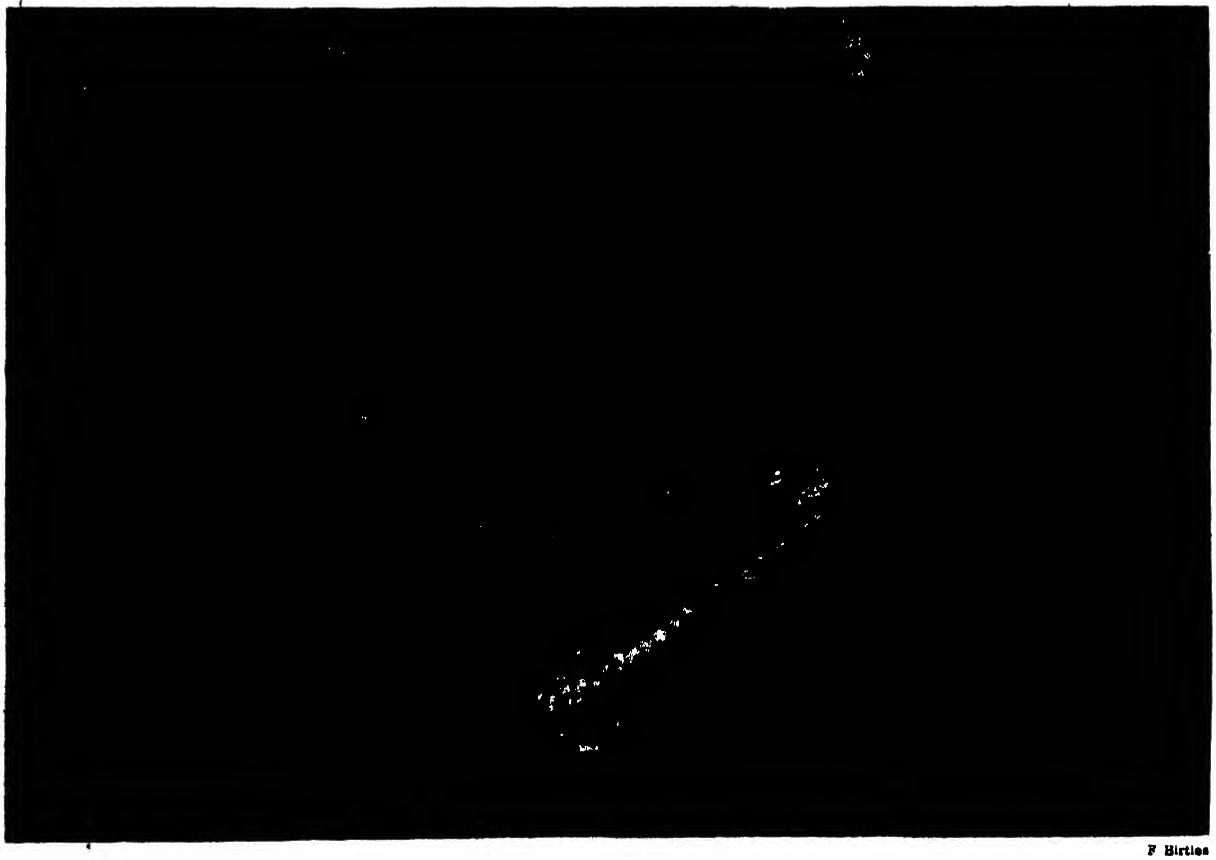
SNAKE FIGHTS IN WHICH THE VICTOR DINES ON THE VANQUISHED

In the two fights illustrated here, the end was not merely the defeat and death of the rival, but a meal as well. In the lower photograph is a mussurana snake which has succeeded in coiling itself fatally round a highly-poisonous jararaca. The upper photograph shows a cribo, from South America, which habitually feeds upon other snakes whether poisonous or not, though the cribo itself has no poison equipment. Here it is seen in the final stages of swallowing a highly-venomous viper.





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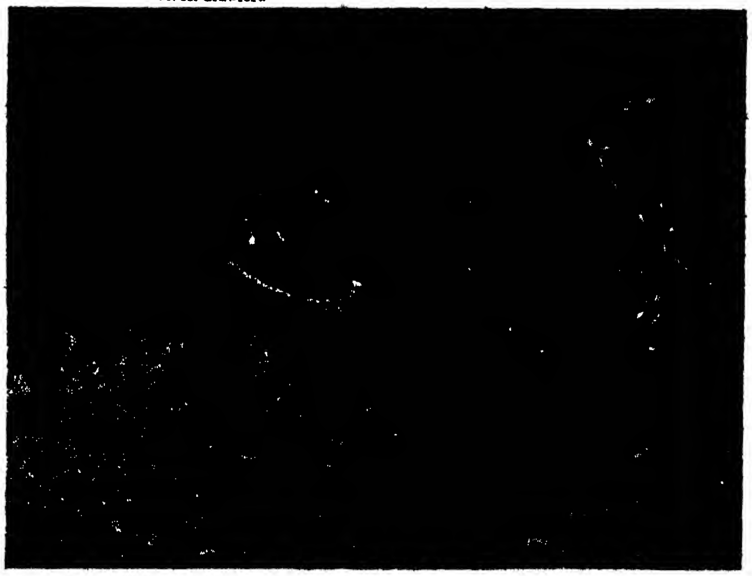
THRILLING DUELS BETWEEN CROCODILES AND BETWEEN PYTHON AND ALLIGATOR

The lower illustration, one of the most extraordinary photographs of fighting animals ever taken, shows two Johnston crocodiles at the fatal end of a contest. The victor, on the right, has got the snout of the vanquished between its deadly jaws and has almost succeeded in drowning its adversary, whose eyes are already closing in the last unconsciousness. Above is a python crushing an alligator by the Rio Oro in Venezuela. The alligator's body can be seen giving beneath the strain, but the python was so wounded that it died also

M. H. Crawford



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SNAPPING TURTLE AND FIGHTING NEWTS

In the New World the alligator-terrapin or snapping turtle (bottom) looks, and is, fierce. It rather resembles an alligator as far as its tail is concerned, and the head is armed with a formidable beak with which it can inflict a dangerous bite. The upper illustration shows two newts striving for the possession of a worm.

not always be composed entirely of brothers and sisters, so that any offensive or defensive measures may thus be looked upon better as reactions for the good of the race and not merely the family, however large the latter may be. This aspect will be dealt with presently.

In the case of the ants defensive fighting is far from being the only evidence of martial temper. Ignoring for the moment the underlying psychology, we may state that every expression of the old Adam in man is paralleled in the ants — sabre-rattling, gladiatorial combats, alliances, little affairs on the frontiers, civil war, poisoning, slave-raiding, wars of aggression, attrition and extermination and wars of zoological species, orders and classes.

Fabre has been called the Homer of the insects, but in that Swiss doyen of natural history, Auguste Forel, the ants have not only a Homer, but, to adopt the phrase of Professor Wheeler of Harvard, a Socrates. Forel's "The Social World of the Ants" is one of the world's recent great books. Indeed, the social insects are very worthily chronicled to-day and, to mention only two more works, the interested are referred to Donisthorpe's "British Ants" and Wheeler's "Insect Societies." From all three books these brief stories take their source.

It is a grim commentary at this date that among the most warlike of ants are the European. Of these, *Neomyrmica rubida* (it has no common name) is the deadliest, but, just as "it is excellent to have a giant's strength but terrible to use it," this form, despite its stinging powers, is not aggressive.

A war of aggression frequently ensues from a strong colony flouting the territorial rights and riches of a neighbouring formicary of the same species. In one species of "wood ant" (*Formica pratensis*) Forel watched a war over a tree rich in the green-fly which the ants "milk" for their sugary honey-dew. If colonies are about evenly matched the campaign may drag on for days until the truce of a drawn war is mutually assented to through mere exhaustion of numbers. As in most clan fighting, the inhabitants are in worse case than at the start, and the only beneficiaries are a third kind, a small and timid species, which ekes out its living by body-snatching.

One of the greatest epics was the War of Zurich between two colonies of the pavement ant (*Tetramorium caespitum*). The terrain was a grass slope before the university, the front extended more than thirty yards, the campaign lasted over a month and the dead numbered thousands. It was as if humans joined issue over a six-mile front and, indeed, the human parallel was not far to seek, for the Franco-German war raged simultaneously.

Continuing these Froissart chronicles of the ants under the heading of "the fight for the race" we may touch on a British species, the blood-red robber ant (*Formica sanguinea*) which is a slave-raider. Raiding, strictly speaking, is usually a bloodless affair of brute force and not one of fighting, though at times single combats arise between invaders and invaded. The war is by siege and sack. The attackers surround the nest, say, of the dark-

coloured species (*Formica fusca*), but allow the garrison to dribble out, or panic away without the honours of war, and seize the undeveloped brood, "which pillage they with merry march bring home to the tent royal of their empress." Regarding the aftermath, Darwin describes how a *fusca* "was perched motionless with its own pupa in its mouth on the top of a spray of heath, an image of despair over its ravaged home."

But in some ant struggles the defenders are in better case; certain African species, the Cremastogasters, live in the spines of acacias, but should one of the aggressive driver ants (*Anomma*) attempt the entrance hole in the acacia spine the Cremastogasters make a blockade with their abdomens from which they squirt their caustic poison.

The terrible people are the nomadic visiting ants, the Dorylinids. They are a turbulent folk and will go for any insect. Many species are blind, their stings are relatively weak, but their jaws are strong, their courage high and furious, and their numbers legion. Against them the hairs and size of large caterpillars are of no avail, nor the agility of a cricket; neither are domestic animals immune.

Rivalling the ants in social organization, and their hereditary enemies, are the termites, and in their order likewise fighting plays its part. This aspect, entitled "The War between Ants and Termites," is treated by Professor Bugnion in a worthy appendix to Forel's book. There are civil wars, but the great struggle, ages long and never-ending, is with the ants. The ants, undoubtedly, are the aggressors. On the whole, too, they are the victors in fighting and it is believed that the infinite variety of the termite defensive measures, soldier caste, equipment, organization and all, are mainly to counter their particular enemies. However, certain cocoa tree termites (*Eutermes*), under certain conditions, as when lichen-gathering for food, do not decline open combat. If their dispositions for defence are sound and their numbers sufficient they will fight the weaving ants (*Oecophylla*) three times their size, and even beat them, their success being largely attributable to their armament of a head gland that squirts a certain disabling sticky fluid.

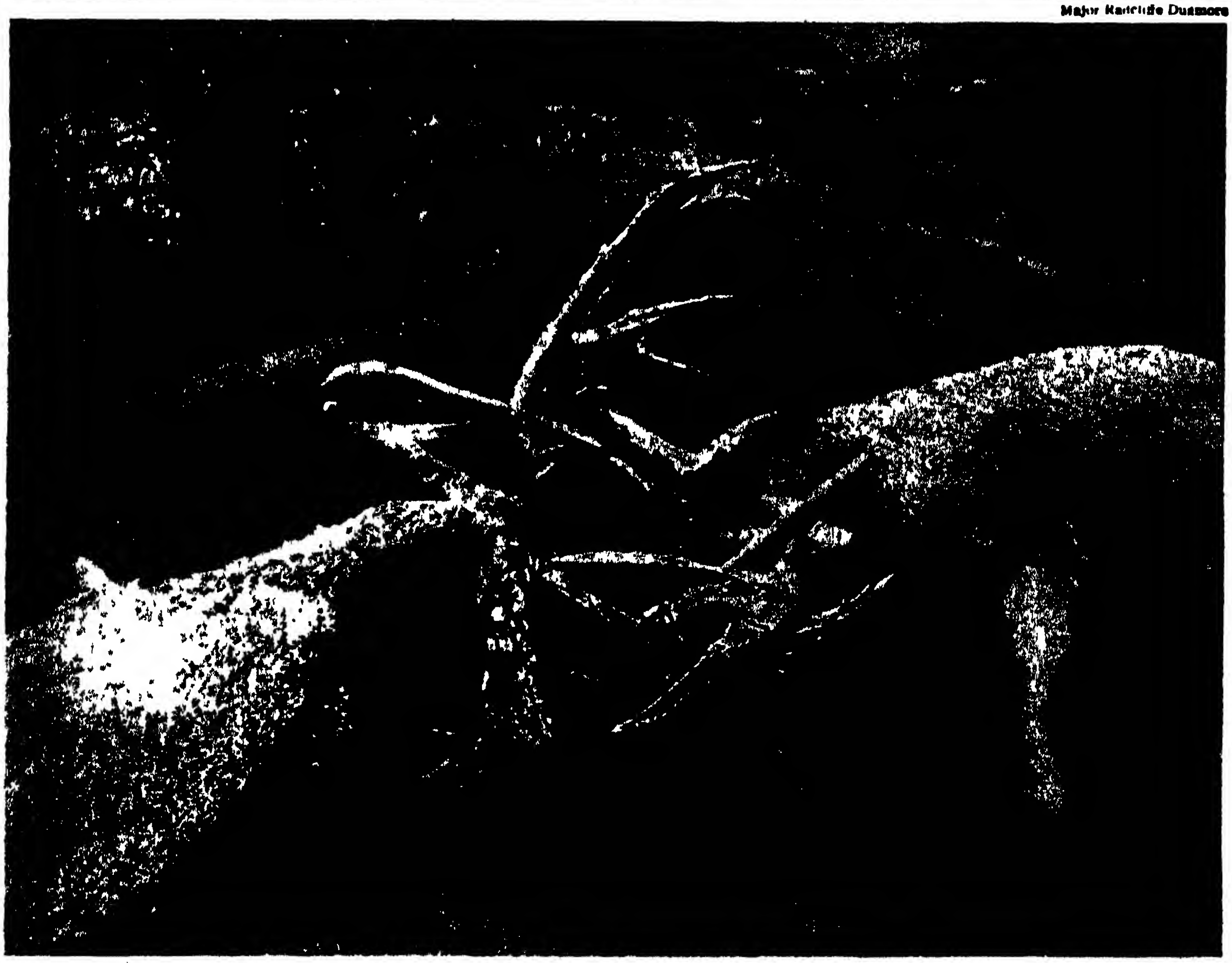
By contrast with these insect studies the defensive fighting of other animals sounds tame, but one or two cases deserve mention. After all, there is something very gallant in the union of small song birds to harass a bird of prey, and something rather noble in the defence of the herd against the carnivora, and the rallying of chimpanzees to the aid of a comrade.

Like many other instincts, the fighting instinct may be modified and transformed, and several examples are very interesting. Man has availed himself of the fighting spirit of his lower brothers. We see this in his utilisation of dogs as protectors, but it is also known that apes may act in the same wise. He has also utilised them for "sport," as in the gamecock; but the quaintest illustration of this is in the Chinese cult of the cricket, which equals,

CAMELS WITH NECKS LOCKED IN A FIERCE GRAPPLE

Camels have an unattractive reputation, among those who use them as beasts of burden, as being surly and extremely vicious. Very often bad treatment and overwork accentuate these characteristics, but in general there seems to be no doubt that the camel is a stupid, disgruntled creature which has never taken kindly to the serving of man. The result of all this bad temper comes fully to light when camels quarrel. The bites they can give are capable of doing considerable damage, and the two seen above are locked in a very grim grapple

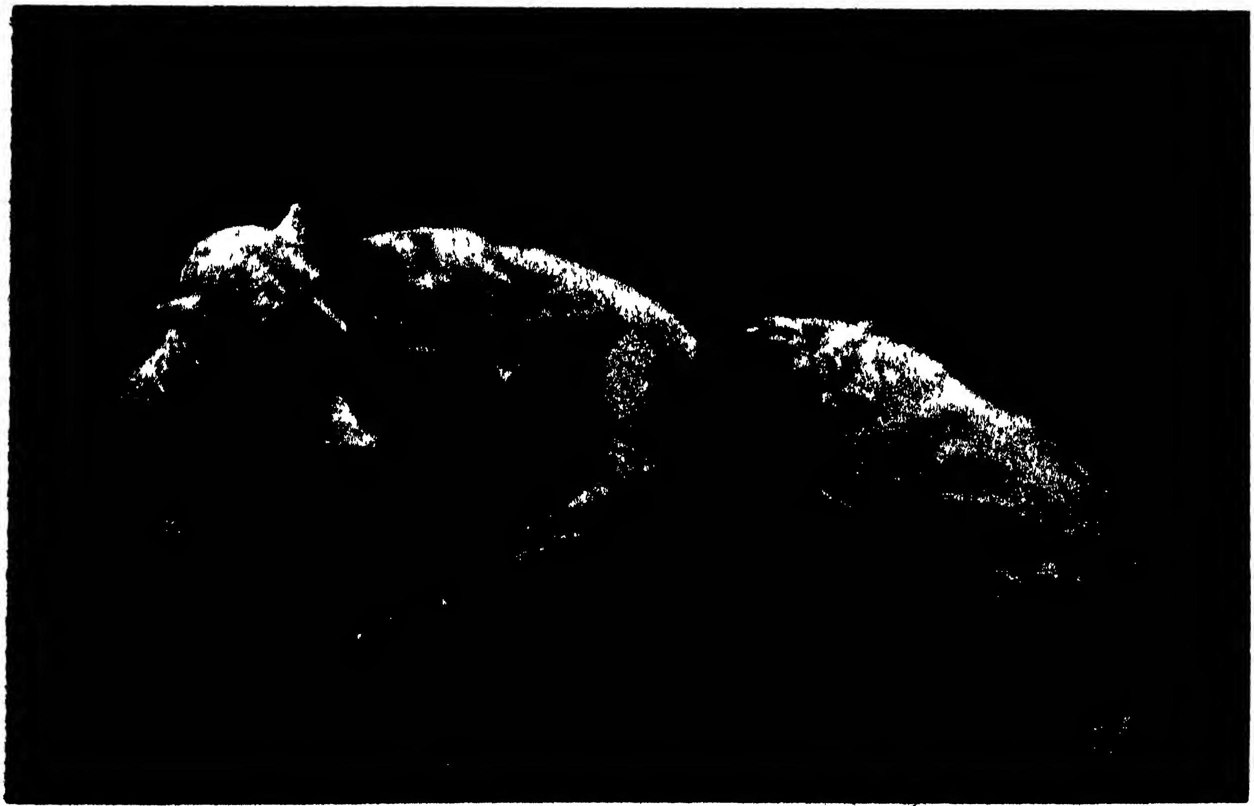
Major Radclyffe Dugmore



Keystone

MORTAL COMBAT OF THE DEER IN THE RUTTING SEASON

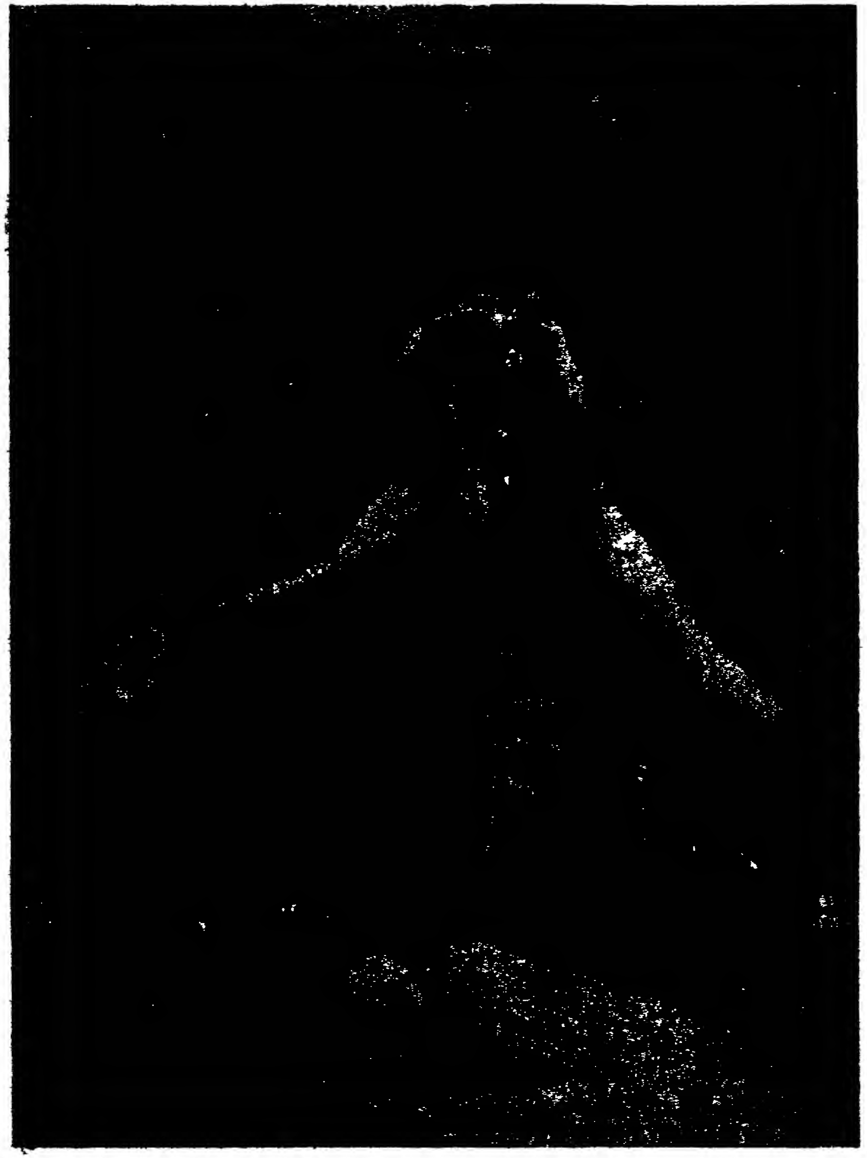
Deer fight very fiercely for the possession of their females during the rutting or mating season. The males, at this time, have just grown their new antlers, and one animal may possess itself of several females when another may arrive and make a bid for their possession (top). Very often these fights have a fatal result, as we see in the lower illustration, where a double tragedy has taken place. Sometimes the antlers get locked together, so that a weakened animal which might otherwise have got away and recovered, dies a lingering death.

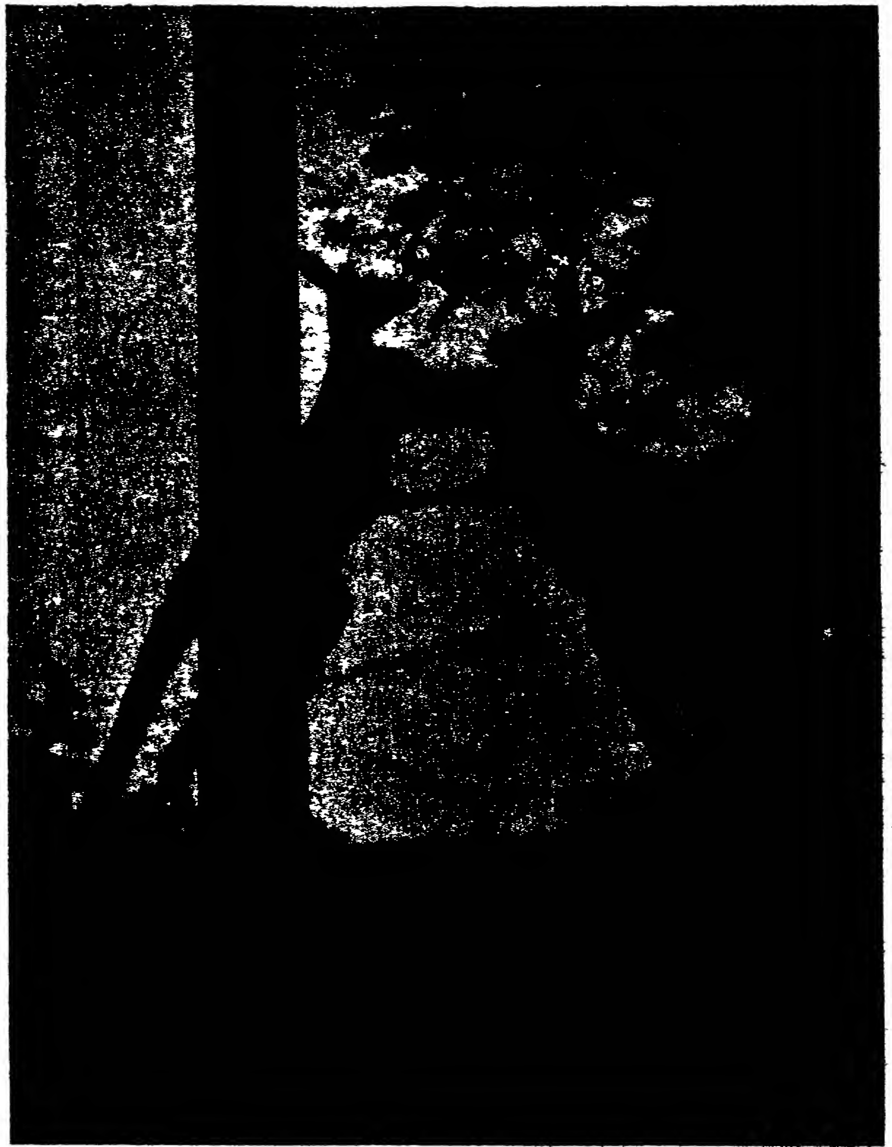


Neville Kingston

DOMESTIC STRUGGLES AT THE ZOO AMONG POLAR BEARS AND PELICANS

When there is more than one wife to a family, as in the case of the polar bear (bottom), strife is inevitable sooner or later, and then it is that the husband must step in, or as in this case, swim in, and, so to speak, put his foot down. We see the male bear intervening lustily between his two angry wives Above is a crested pelican which has taken possession of a convenient perch, and very much resents a move on the part of a common Australian pelican to share it. The attitude of the former suggests what will happen if the latter should persist.





HOW SEA LIONS AND KANGAROOS SETTLE THEIR DIFFERENCES

While the sea lions (left) look happy enough at the Zoo in their large swimming pool edged with artificial rocks whence they can indulge in their favourite pastime of diving, yet everything does not always go smoothly even with them. The sea lion is apt to get pugnacious and fretful and his teeth can pay off old scores very well. Kangaroos, too, are excellently equipped for fighting and administer frightful kicks with their hind legs. As though to guard against such kicks these two are standing well away from each other's hind claws and wrestling for position. Indeed their attitude is strangely like the preliminary grip of a certain historic style of English wrestling.

if it does not beat, cockfighting. The Chinese have an innate interest and sympathy for insects above all other animals, so much so that the cicada, a symbol of resurrection, the praying mantis, a symbol of bravery, and the butterfly and the dragon-fly are held in highest esteem both artistically and religiously; while the fighting crickets are regarded as incarnations of legendary heroes and have a literature that is all their own.

The fighting instinct in the different pugnacious species of crickets is supposedly attributable to the fact that the insects continually have to guard and maintain their holes against all comers. The points looked for in a fighter are loud chirping, long legs, big head and neck—the fighting parts—and broad bodies and backs. They are called " generals " and " marshals " and are pampered to the full. In training they are nobly fed on special food, including blood-filled mosquitoes, which have gorged on the arm of the fancier, and a tonic soup of a special flower. Before the fight, and to excite ferocity, they may be compelled to fast for some considerable time.

IBEX HORNS ENTANGLED IN BATTLE

In this position the ibex twists and pushes, manoeuvring for position with its rival. This species of wild goat is especially remarkable for its fine curving horns, which are used with effect in the mating season. These horns are armed with transverse ridges which give a serrated surface to their already formidable weapons.

Their are heavy, middle, and light-weight contests. In special places, and in special bowls on silken covered tables, the contestants are matched, what time their past form is recited by the referee, styled the " Army Commander " or " Director of the Battle." He excites them by special fine " ticklers " of grass or hair until the issue is joined. The weapons are the biting mouth-parts, which are used with the utmost ferocity, and the battle is to the death. Victory is achieved, not uncommonly, by the " better man " dropping with the whole weight of his body on the back of his fellow gladiator and beheading him. Their fame is scrolled on ivory tablets, frequently in letters of gold, a champion of many victories being a " conquering cricket " (*shou lip*), a champion of champions a " Grand Marshal."

What may be called a twisted instinct is shown in singing birds when they defend the changeling egg or young cuckoo by worrying a full-grown cuckoo that approaches the nest. The beginnings of the dangerous spirit are seen in the *hamadrya* and *gelada* baboons whose respective clans shriek and bellow dislike and defiance at one another. Unnatural conditions too, breed bad feeling and blows; a captive idle baboon may tease a dog, and Professor Yerkes has observed the malicious glee of a young ape inciting his elder companions to fisticuffs by pretending that he had been attacked. In Nature, to use an Irishism, the unnatural conditions induced by the thwarting, on the part of the older animals, of the mating instinct in young male seals and vicunas, lead to constant quarrelling. And, just as in Northumberland and Durham, the Sword Dance really symbolises an ancient heroic fight, so we see a similar transmutation of fighting behaviour in the sports of many animals.

All great students of the order state that many kinds of ants play at fighting, while bird lovers know that ruffs and blackcocks have sham battles which are apparently ferocious but which really serve to rouse mating excitement. It is even stated, and this the specialist may deny, that stag-fighting is really a sport; for the stag, in deliberately seeking out the challenger and thereby risking his whole harem, seems deliberately to go out of his way to battle. One would think, however, that the fighting instinct, no matter how strong, would be subordinate to the instincts of mating and proprietorship.

And the upshot of all this brute belligerency? Is the battle really to those that swing the sword; or shall they perish by it and the meek inherit the earth? For the rival societies of termites and ants—the former mainly non-aggressive in respect of the other—are both successful to-day; so are the peaceful herbivorous herds and their enemies the predatory carnivores. To these questions we shall probably never know the answer, for man in his steady conquest of Nature, to paraphrase the Rubaiyat, is grasping this Scheme of Things entire, shattering it to pieces and remoulding it nearer to the Heart's Desire. Yet even Man in his conquering arrogance may still go to the ant and be wise!

But however powerful the influence of man may become, surely this complex thing which we call, for want of a better term, the fighting instinct, will remain one of the most durable of animal characteristics.

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WEDDELL SEALS OF THE ANTARCTIC BASKING ON ICE FLOES OFF ROSS ISLAND

When Scott made his heroic and fatal dash to the South Pole he fixed his winter quarters on Ross Island in January, 1911. It is on the same island that the Weddell seals seen above are basking in the Antarctic sun, which, strange as it may seem, provides a very comforting warmth even when fallen snow is lying thick upon the floes. The animals are enjoying a rest at the foot of an ice cliff of dazzling white and show up conspicuously against their snow background. Presently they will stir and flounder to the water's edge, when, with a dive, they lose all awkwardness and become swift-moving creatures of the sea. They are named after the explorer Weddell who also gave his name to the bay called the Weddell Sea.

Chapter XXXII

As the Poles Asunder: Animals of the Arctic and Antarctic

By J. L. Cope

Commander, British Imperial Antarctic Expedition

The chief differences between the Arctic and the Antarctic Continents lie firstly in the fact that whereas the Antarctic Continent is a land mass (roughly two and a half times the size of Australia) surrounded by water, the Arctic Continent is a mass of water surrounded by land; and secondly that there are no quadrupeds in the Antarctic, the first part of the statement really explaining the second.

In the Southern Polar Continent the mean summer temperature is seldom much above freezing point and vegetation is scarce: the little that does exist is cryptogamic, and comprises fungi, lichens, mosses, and some fresh-water algae, but there are no flowering plants on mainland or island.

In both the Arctic and the Antarctic regions marine life is prolific and there is a similarity between them. This has given rise to what is known as "the problem of bipolarity," that is, the theory that certain species have been enabled to travel from one frigid zone to the other. But against this many zoologists maintain that all such species which resemble each other in the Polar Seas are cosmopolitan and are found in the intervening seas and, generally speaking, the question of bipolarity is entirely unsupported by a study of the fish life and is not accepted by modern zoologists.

In the south, alar life is common both on land and sea, being represented in particular by such varied forms as the skua gull, snowpetrels and the ever attractive penguins.

The penguins are birds that have been specially adapted to lead an aquatic life, and they seek their nourishment entirely in the sea. The food consists of minute shrimp-like animals known as copepoda, which they catch on their tongues by swimming through water in which these crustaceans are dense. Their beaks remain partially open. The tongue of the penguin is barbed, and as the water flows in at the front of the mouth and out at the back on each side, the shrimps are caught in the barbs of the tongue and quickly swallowed.

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SKUA GULL CHICK

As a rule the skua gull, which gets its living by preying on young penguins, lays two eggs only. The newly-hatched chick above was taken from an adjacent nest and placed on this pair of eggs for the sake of comparison Notice the absence of any nest.

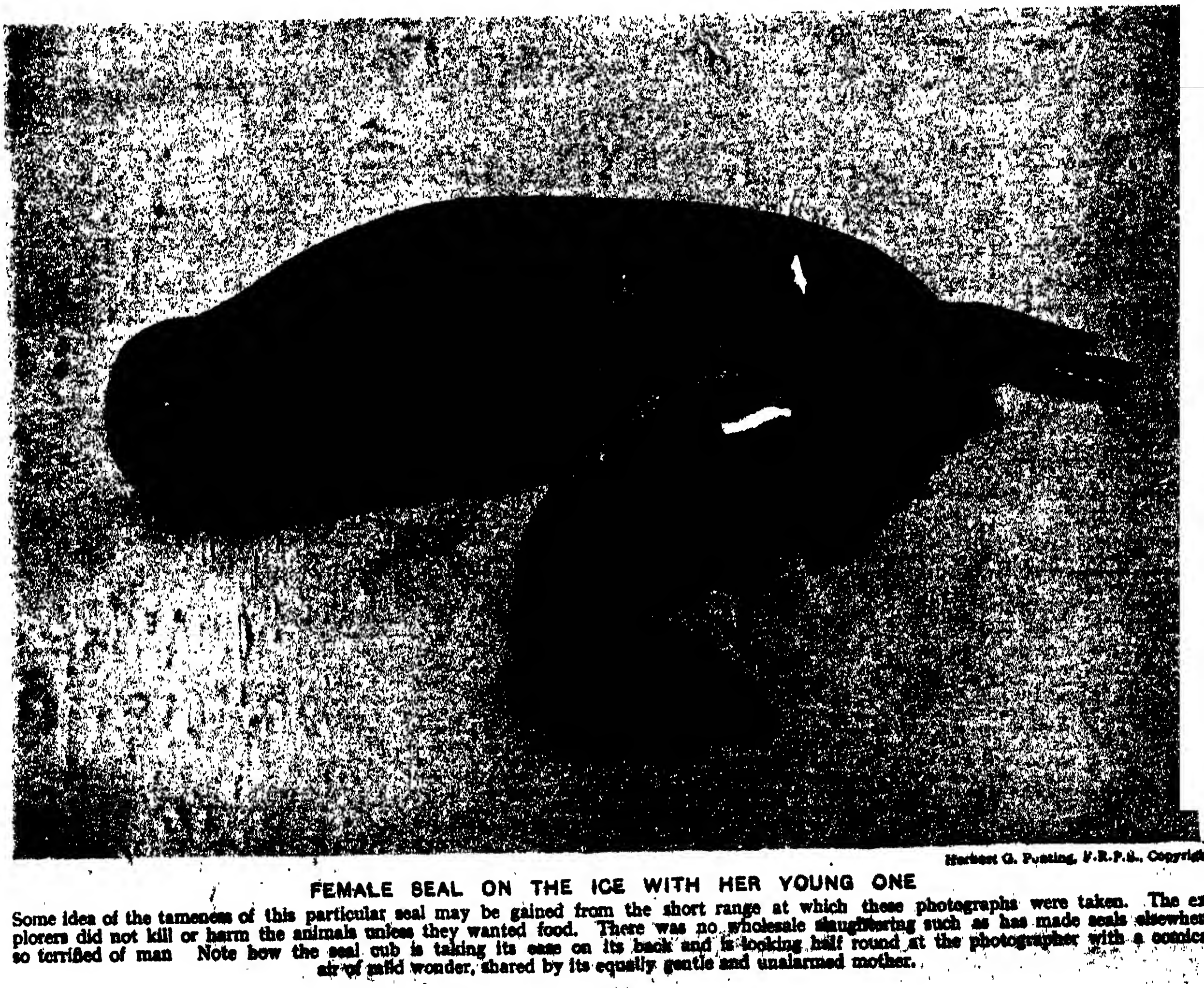
The young birds are at first looked after entirely by the female, the male parent obtaining all the food for both his wife and children. Often he fills himself so full that the food dribbles out of his mouth as he waddles with great difficulty, owing to his temporary corpulency, back to his nest of stones. He feeds both mother and young by regurgitating portions of his stomach contents into the lower beak, from which his family peck at it.

The largest species of penguin is the emperor penguin, which is found on the most southerly edge of the Great Ice Barrier. Here it breeds in midwinter. The bird is enabled to do this by important anatomical and physiological specialisations, such as having a special pouch in which to keep egg and young warm during the severe winter, and by accumulating a large amount of blubber on which to feed as, of course, it is unable to get the copepods in the winter, the sea being frozen over.

Every other species of penguin, except the emperor penguin, goes north as the Antarctic winter approaches, partly by swimming and partly by resting on drifting icebergs and floes

The habits of the penguins have been carefully observed - and in many cases recorded by the kinematograph, and perhaps their most striking characteristic is their social organization; they are intelligent, and the only "civilized" denizens of the far south.

It has been said that stories concerning penguins are like those of anglers, but the writer can vouch for the truth of this one. In the mating season the male proposes to the female by carrying a stone in his beak and placing it at her feet. If the lady accepts the gentleman's proposal she does so by picking up the stone in her beak and moving it towards her. One day a member of a recent



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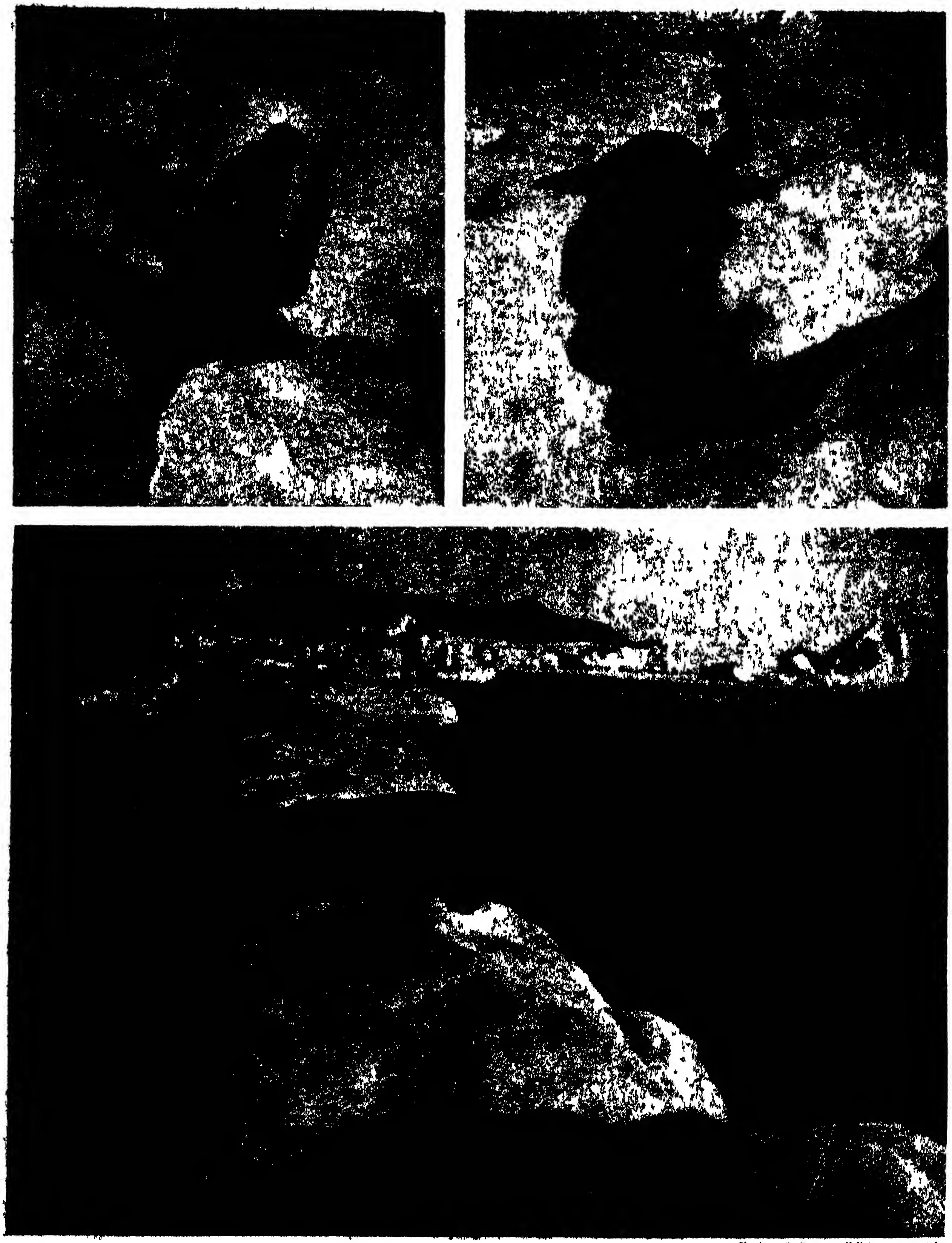
FEMALE SEAL ON THE ICE WITH HER YOUNG ONE

Some idea of the tameness of this particular seal may be gained from the short range at which these photographs were taken. The explorers did not kill or harm the animals unless they wanted food. There was no wholesale slaughtering such as has made seals elsewhere so terrified of man Note how the seal cub is taking its ease on its back and is looking half round at the photographer with a comical air of mild wonder, shared by its equally gentle and unalarmed mother.



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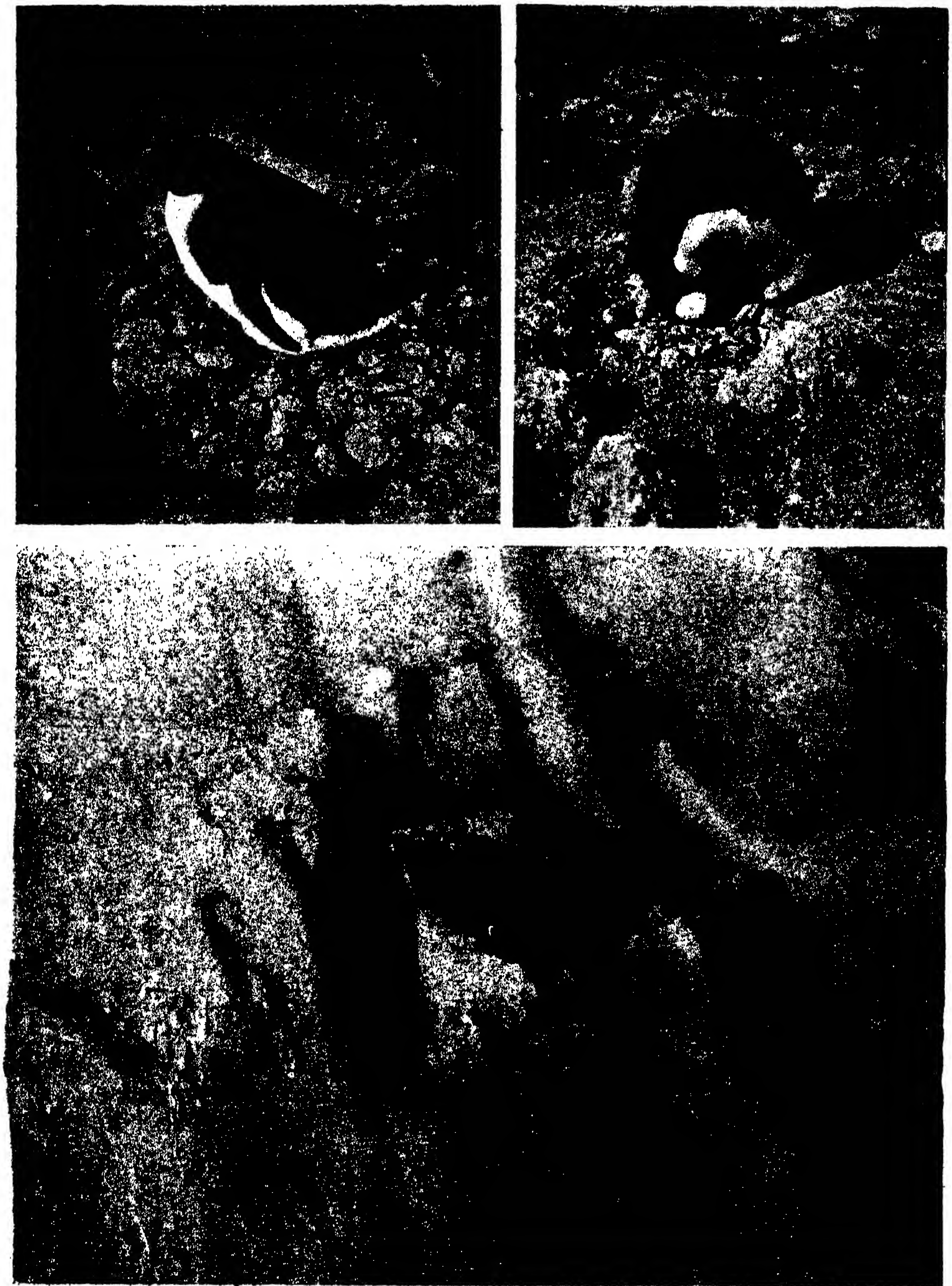
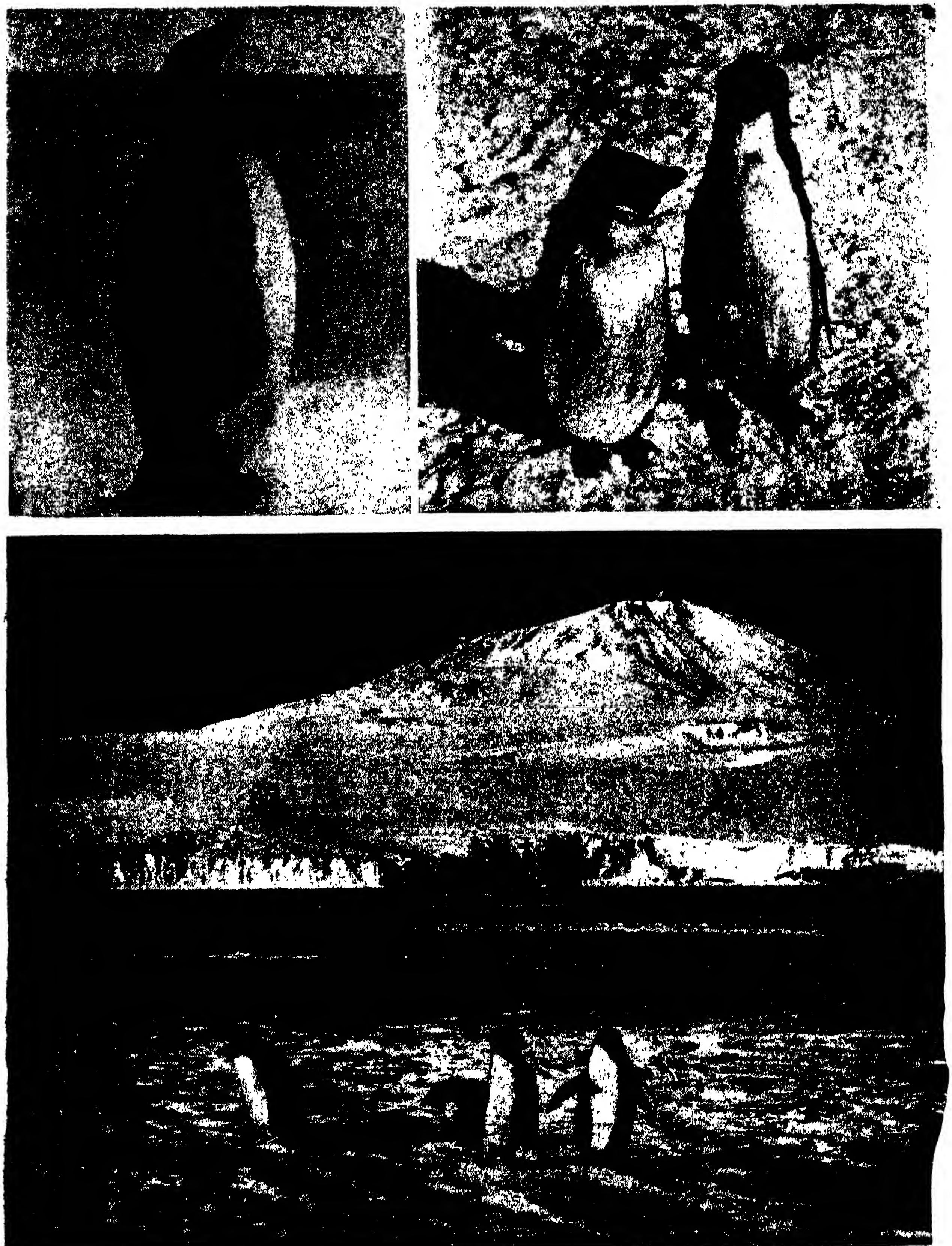
WEDDELL SEAL AND THE CONDITIONS UNDER WHICH IT LIVES

While the seal has to seek and find a place where it can mount the edges of the ice cliffs of various heights which form much of the "coast" of the Antarctic, it can depart into the sea very much easier, for it is an expert diver (bottom). In the winter the seal must keep a hole in the frozen sea free from ice so that it may fish. Periodically it comes up to breathe (top left). The top right hand photograph shows a seal from the back, when its flippers have gained a hold, and it is just heaving half out of the water



DEVOTION TO DUTY IN THE PENGUIN'S NESTING SEASON

Even a blizzard will not drive the penguin off its nest (bottom), and it will sit valiantly on while the snow gradually mounts higher and higher about it, until finally, as here, only the beak and an eye are left in the air. The eggs are incubated on a pile of stones (top left), and every now and then the eggs are turned (top right) for the sake of airing them, an operation which is frequently repeated, despite the temperature. The Adélie penguin breeds in the Antarctic but goes north in the winter.



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ADELIE AND EMPEROR PENGUINS, SOCIAL COLONISTS OF THE FAR SOUTH

Penguins live in communities, and in some other respects also are remarkably like human beings. The wonderful photograph here (bottom) shows a few Adelie penguins resting on the snow with the cone of Mount Erebus, an active volcano over twelve thousand feet high, in the background. The top right-hand photograph shows two Adelies who are mated, and the remaining illustration is of an Emperor penguin, a species which attains a greater size and does not swim north for warmer climate in the winter as the Adelies do.

ONE OF THE KING PENGUINS

Next to the Emperors in size come the King penguins, which, when young, are distinguished by their dark brown coats. A brown-yellow tinge is a feature of throat and breast in the adult, in contrast to the white-fronted Adelies

Antarctic expedition was sitting on a rock in December, the Antarctic midsummer, writing up some scientific observations, when he felt a penguin pecking at one of his trouser-legs. He tried to shoo the animal away, but the bird was persistent. The man looked from his work down at the penguin, and one can easily realize his embarrassment when he discovered that the reason of the penguin's persistence was that it had placed a stone at his feet!

THE mammalian life in the Antarctic is entirely marine and consists of several species of whales and seals. The whales only inhabit the south polar waters in the summer when they are not frozen over, but the seals remain south all the year round, and during the winter live by blow holes which they keep open in the sea-ice.

Land animals are non-existent in Antarctica for the reason already stated in the opening paragraph of this chapter, but minute wingless insects, degenerate in type, have been found. In the fresh-water ponds microscopic life is prolific; here are found the Tardigrada or "water bears," and the rotifers. These animalcules have a wonderful power of resistance to low temperatures and have been thawed out of blocks of ice chipped from the ponds, having been frozen solid certainly for months and it may be, when a pond failed to thaw in a severe summer, for very much longer periods still.

The Antarctic continent in regard to birds and mammals cannot be considered a separate zoological province. Its fauna for the most part consists of certain generic groups of seals which, it is true, are peculiar, but which live as much on the pack-ice as on the continental shores. The species of penguins form a group which is common to the extremities of all three continents of the south, and the other birds mentioned are all found to a greater or less extent elsewhere outside the south polar regions.

When the great southern land mass, known as Antarctica, separated off from the other continental masses by vast stretches of ocean, and gradually became devoid of vegetation, the penguin, as may be easily appreciated, developed aquatic habits which would enable him to pursue his food northwards as the sea froze over in the Antarctic winter. In the north no such events occurred, and this explains the absence of the penguin in the northern polar region. But now, in the water, the penguin, withal his having the appearance of a fine gentleman in evening dress when strutting about over the ice and land, has two serious marine foes in the shape of the killer whale and the sea leopard; while on land, where he is flightless and therefore helpless, the skua gulls rob him of both eggs and young.

BRITISH, French, and Belgian, German and Swedish expeditions have investigated the marine fauna of the Antarctic and since 1900 have added several surprises to the world's knowledge of the fish life of the continental coast and sub-Antarctic islands, such as the relationships of the marine life of South Georgia and Graham Land and the fact that this in its turn bears no resemblance to that of the Magellan-Falklands area. This diversity has occupied a long evolutionary period, and the continent may have lain in the midst of a cold ocean throughout the Tertiary geological period.

Our knowledge of the oceanic life in these parts has been added to especially by the German "Valdivia" Expedition. The abysmal fauna are poor. There are fishes of a dark coloration, prawns of a deep red hue and other bathypelagic organisms. The less deep waters are inhabited by small silvery fishes having large eyes, many small crustaceans, pteropods, and suchlike organisms. In still less depths predaceous fishes with swarms of foraminifera, radiolaria, copepoda, siphonophora and medusae are found. The vertebrate fishes are mostly silvery in appearance with a blue back, while the invertebrate are generally transparent and colourless.

In the surface waters of the ocean microscopic plants, known as microplankton, abound. These plants are nourished by the soluble inorganic substances of the sea water and carbon dioxide, and they form the nutriment of most young marine life, termed animal plankton, such as the small crustaceans and the larvae of fishes. These in their turn form the food of deep-sea fishes, and the smaller of

the pelagic fishes become the prey of the larger pelagic life. Thus the distribution of fish life depends greatly on the microplankton and generally speaking these are abundant along coastal regions, but in the open sea are present in greater quantity in the cold regions than in warmer seas.

In dealing with the north polar regions we have, in addition to a more extensive animal life, a very prolific plant life to consider. The flora of the Arctic regions is restricted to the lower lands which are snow-free for a considerable period annually, and it extends to the most northerly land known to man. The growth is lowly, but there are also dwarf shrubs, and it is mostly phanerogamic and cryptogamic. There are some grasses which reach a height of eighteen inches and also some moss-cushions over one foot in depth. Many have brilliantly coloured flowers. Peary Land, lying to the north of Greenland, and other parts are so densely vegetated as to support rodents and ruminants in large numbers. The plants appear regularly every summer in the natural economy of the land, the low temperatures being unable to check the continuance of plant life in the fertile soil.

The Arctic Ocean is well stocked with animal life. *Balaena mysticetus*, the whalebone whale, is now practically extinct by reason of past commercial activities, but in the open waters to the farthest navigable north the white whale and the narwhal are plentiful.

Walrus and seal live on marine life, and the polar bear, Monarch of the Arctic, preys over the whole of the icy vast upon seal and fish. It is curious to note how the walrus and the bear have protective coloration, the one for the sea and the other for the land. The walrus is black, so that he may be less conspicuous in the icy blackness of the cold waters; while the polar bear is clothed in a whiteness that renders him less visible to his prey in the surroundings through which he tracks.

The Arctic fox and wolf are other examples of Arctic carnivores, and the wolf attacks all others save the polar bear and the musk-ox. In the circumpolar

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OCTOPUS CAPTURED IN THE ICY SEA OFF CAPE ROYDS

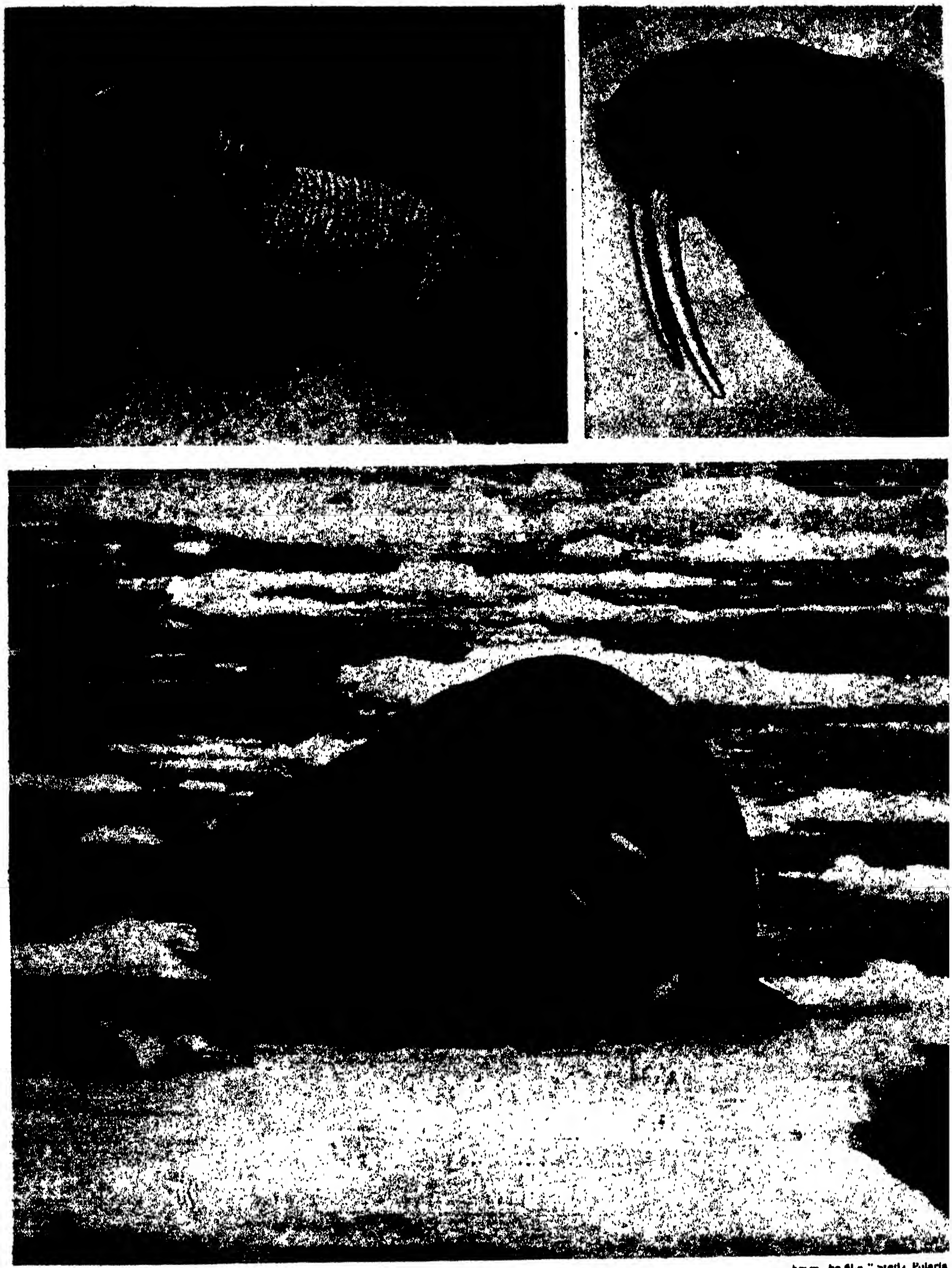
This creature measured more than three feet from tip to tip of its tentacles, and was caught off Cape Royds during the Scott expedition. It was the first octopus known to have been captured in these latitudes. It is frozen stiff as it lies there on the snow, and beside it is the folding measure with which the creature's dimensions were gauged. Polar waters are more prolific of life than any others, but, even so, it is seldom that residents in warmer seas, such as this, travel so far from their homes.

E.N.A.

From the film 'Stella Polaris'

MONARCH OF THE ARCTIC IN HIS KINGDOM OF THE SNOWS

Away from the haunts of men the Polar bear has little to fear in his frozen domain, and preys upon seal or fish unmolested. The coat remains white all the year round, and the long neck and small snake-like head distinguish this from all other species of bear. But when man invades the regions where this great white beast is found he usually does so accompanied by the fierce Eskimo dogs, whose favourite pastime is the hunting of Polar bears (top). Ten dogs are usually a match for the largest and fiercest bear



From the film "Stella Polaris"

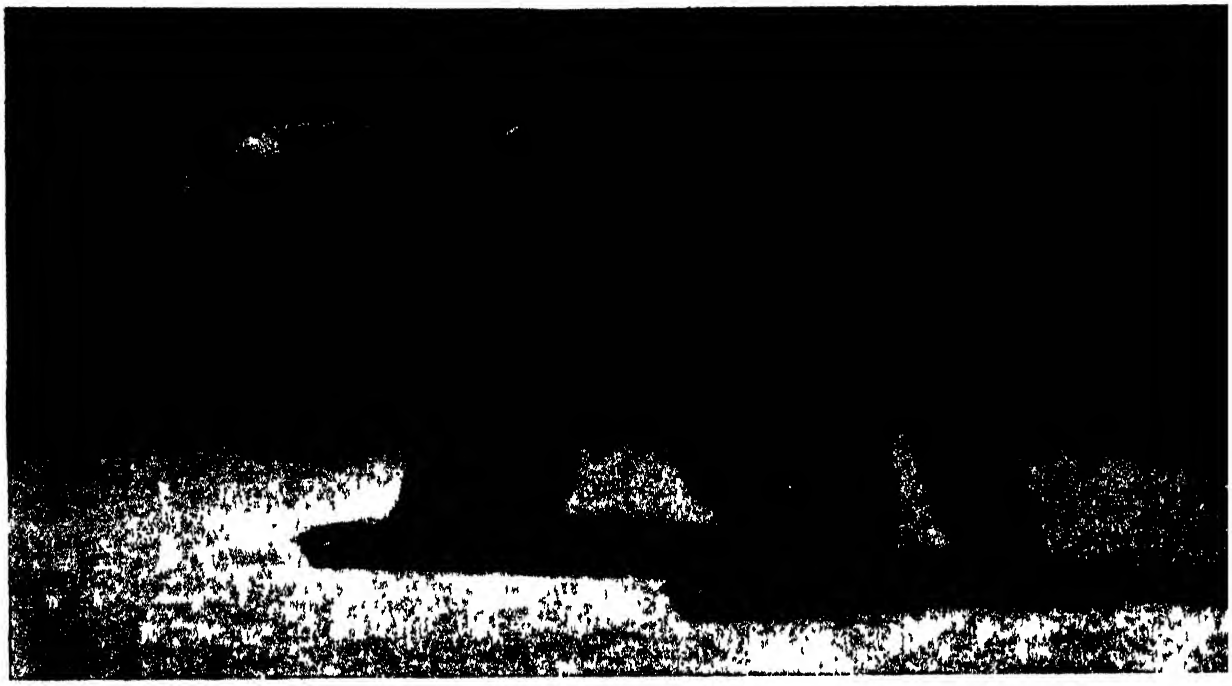
GREAT SEA MAMMAL OF THE NORTH—THE WALRUS

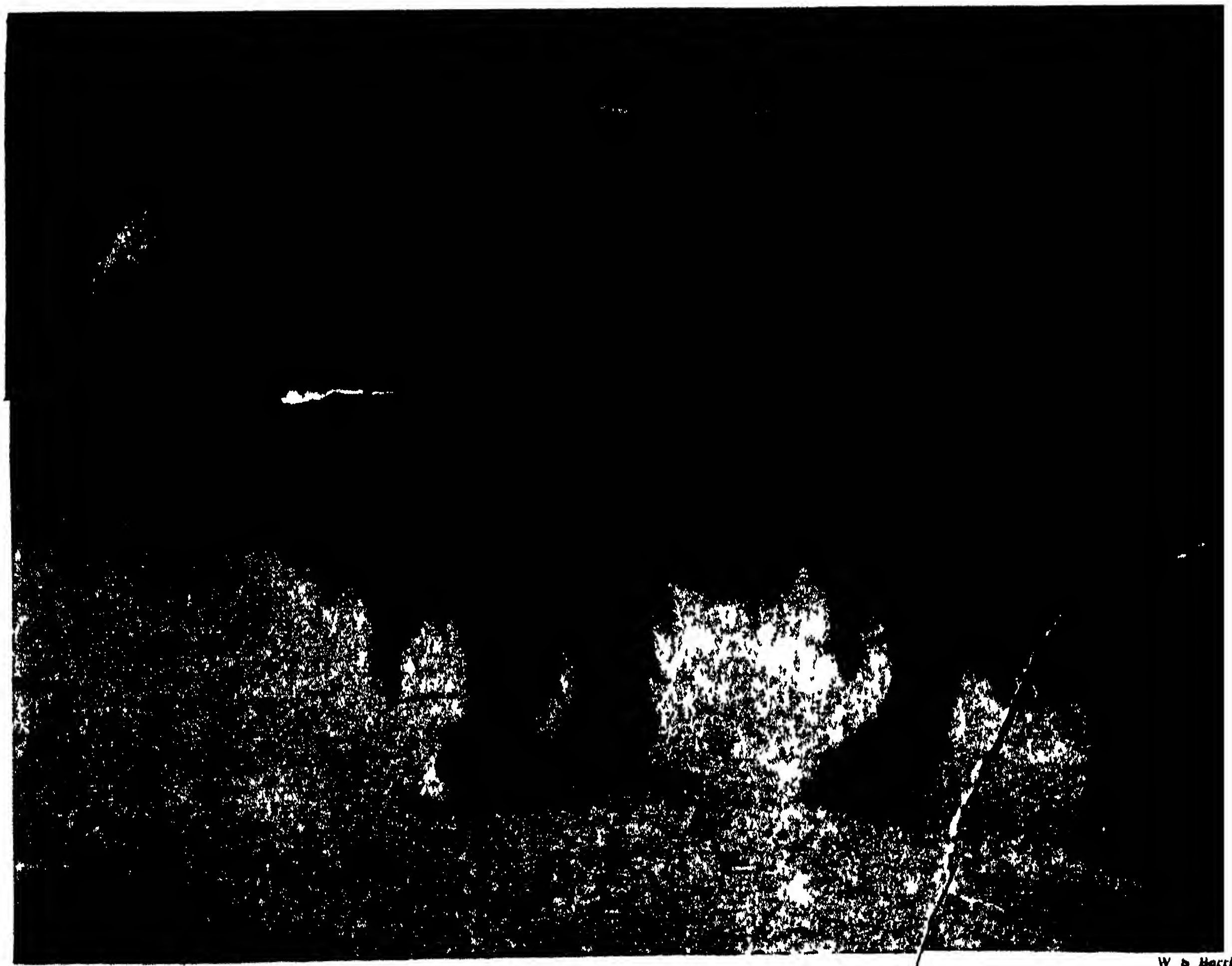
When full grown a male walrus may weigh 3,000 pounds and measure 12 feet in length, and is a formidable antagonist for even the Polar bear. Ruthless hunting has tended to drive it further and further into the uninhabited North. When young (top left) the fur is light brown, but with maturity the coloration becomes uniformly dark to harmonise with the dark of the cold seas. The tusks (top right) grow a foot long and more in the adult male, and are used for breaking molluscs, the principal food of the walrus, and for fighting.

From the film "[illegible]"

SEAL CLIMBING A CLIFF AND A HERD OF SEALS ALARMED

While found in all seas that are not actually tropical, the seal abounds mostly in the Arctic and Antarctic. It is an animal which has cleverly adapted itself to a marine life. The tail and hind limbs have become united for swimming purposes in the true seal as opposed to the walrus and sea lion, and are useless on land, where the seal drags itself along by its fore-limbs or flippers. It can even climb cliffs thus (bottom). It was the seals' clumsiness and their habit of collecting in great herds (top) that enabled the old sealers to slay such thousands.





W S Berridge

MUSK OX AND WOLVERINE, DWELLERS WITHIN THE ARCTIC CIRCLE

Inhabiting country where, even in summer-time the surface of the soil scarcely thaws, the musk-ox takes its name from the flavour of musk with which its flesh is tainted. The head is rather sheep-like in appearance, and the apparent size is much greater than the actual size, since the thickness of its coat, necessary in the Arctic cold, is tremendous. Actually the musk ox is only about two-thirds as large as the American bison. The wolverine or glutton (top) is circumpolar in distribution and measures about three feet in length

Antarctic as do the ... and southward from the Arctic as do the migrant birds; or the amount of blubber is increased as a food reserve before the winter sets in, as occurs in the emperor penguin of the south and in the polar bear of the north. The warm-blooded polar animals, north and south, are blubber-bearing animals because, in addition to the blubber being a food reserve at such times as in the winter and during the breeding and moulting seasons, when foraging for various and obvious reasons is difficult, it enables the animals to keep warm and resist the intense cold, blubber being a bad conductor of heat. On the coasts of Greenland life does exist and a most peculiar phenomenon is the presence of dense clouds of mosquitoes in the summer as far north as this, just as they

lands of the north wild reindeer exist, but they are not found in Franz Joseph Land, and to-day the musk-ox (*Ovibos moschatus*) is only found in large numbers in parts of Peary Land and the American Arctic Archipelago.

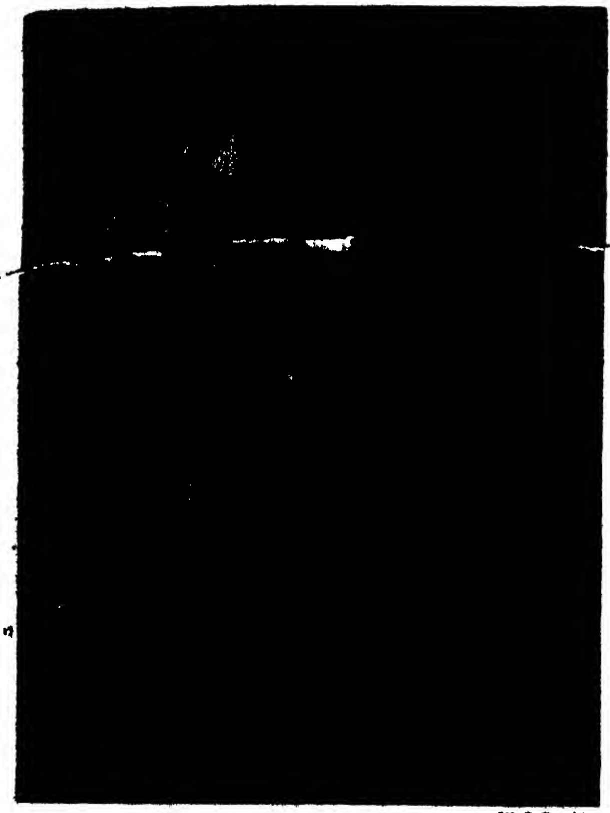
One of the most characteristic of the Arctic vertebrates is the Arctic hare. This animal and the lemming occur most abundantly. Fur-bearing animals, including the well-known ermine, are not so plentiful as once, owing to the demands of Dame Fashion.

Generally the animals are of white coloration and either, like the polar bear, remain so, or, like the hares and lemmings, are brown in summer, matching the surrounding verdure, or white in winter in harmony with the fallen snows.

As in the Antarctic, the alar life of the Arctic regions is a migrant one. In the polar winter the birds go southward and the coastlands teem with their nests; while in the summer the birds penetrate to the farthest corners of the north.

GREENLAND, in the interior, is an elevated plateau on which, as on many of the large Arctic islands, vegetation and animal life are absent. This is because, owing to the great altitude, there is a permanent snow covering and an extremely severe climate.

Thus food necessary to sustain animal life is wanted here and the intense cold is a further barrier to existence. Elsewhere, as we have seen, the food supply in summer is at least sufficient, although at times existence may be precarious. In the winter animal life either follows its food northwards from the



W. S. Berridge

ARCTIC FOX AND THE TIMBER WOLF

Inhabiting almost all the Arctic lands, the Arctic fox (bottom) has a blunter muzzle than other foxes. It feeds largely upon Arctic birds and their eggs. The timber wolf (top) is sometimes held to be merely a local variety of the American grey wolf.

DOG TEAM TRANSPORT AS USED IN THE ARCTIC

In the far north, and especially in Alaska, the best means of transport is by dog-drawn sledge The animals used are Eskimo dogs, that are virtually a breed of domesticated wolves which frequent interbreeding with the wild wolf tends to keep wild and hardy The Eskimo dog rather resembles a large chow with a rough coat, bushy tail, ears held erect, and a sharp-pointed muzzle Ten such dogs can pull a load of 2,000 lb over a good surface. This photograph from " Four Years in the White North " is copyright, 1918, Harper and Brothers

are found in much lower and warmer latitudes Mosquitoes are also abundant in the summer on the marshy tundras of Siberia. The explanation is that the eggs at the end of summer lay in the water in the ground, and become encysted to withstand the freezing winter cold. When they hatch out in the hot summer sun which has then been shining day and night for a considerable period, they do so in such vast numbers that the dense clouds mentioned are formed

Lastly, in connexion with the Arctic must be mentioned its human inhabitants the Eskimos. In the far north of the continent the conditions of life are extremely severe especially as regards temperature. Their life is a communal one, spent mostly in fishing and hunting. They live by foraging, and a serious menace to this method of existence is the occurrence of ice deserts. But they wage a war against nature which, if eternal, is successful.

The polar regions abound in life but in the south the marine fauna is prolific (probably more so than in the north), while the terrestrial flora and fauna are poor. In the north both marine and terrestrial fauna are abundant and the terrestrial flora, taking all conditions into notice, may almost be described as prolific and certainly as wonderful.

Both northern and southern polar expeditions have found there can always be a supply of fresh food if the foraging is cautious and persistent, but such supplies are obviously much more plentiful in the north, the north is more liveable or as Stefansson has said and shown, it is a " liveable north " and a " friendly Arctic "

STEFANSSON in his book "The Fruitful Arctic" speaks of the friendly Arctic as " signifying that to those who know how to live there, to those who imitate the habits of the Eskimos themselves and of the many other kinds of mammals who keenly enjoy life there, this region of the long Arctic night and of the bitter cold is not hostile, but friendly." Flowers, mosses, lichens are plentiful and among the grasses even the cotton grass flourishes There are vast grazing resources and already reindeer are important meat-producing resources in Alaska and in the northern half of Canada, which is one vast pasture or " verdure-clad prairie." In this connexion, reindeer do not have to be fed or stabled, living as they do in and on the open country, and they are, in contradistinction to caribou, which are merely wild reindeer, as domestic as sheep. This was realized, practically, in China as long ago as the fifth century, and in Norway in our own King Alfred's time, and to-day Stefansson has established a large and flourishing industry on Baffin Island.

In " The Liveable North " he says, " The course of civilization has been northward since its dawn. The races of the colder climes have predominated in world power, and man, although a tropical animal, is not

W S Berridge

at his best in the tropics. To-day old imaginary difficulties of the North are shown to be fairy tales and inaccuracies and the far north is being conquered as time goes on."

There is a heavier snowfall in Virginia or Germany than in either northern Canada or Alaska. North Polar life, and especially as regards vegetation, depends on the total number of hours of sunlight and not on the number of summer months. In the three months Arctic summer there are as many hours of sunshine as in a tropical summer of five months duration, thus giving northern plants twice as long a growing period. Life, both mental and physical is developed to the highest. The mineral resources of the far north are literally colossal. The climate and civilization of the north will combine to produce " men of unsleeping energy and restless ambition."

Man's knowledge of the Arctic and the consequent development of its resources is vastly greater than that of the Antarctic. Until Antarctic exploration is followed by men of practical as opposed to academical experience this state of things will remain.

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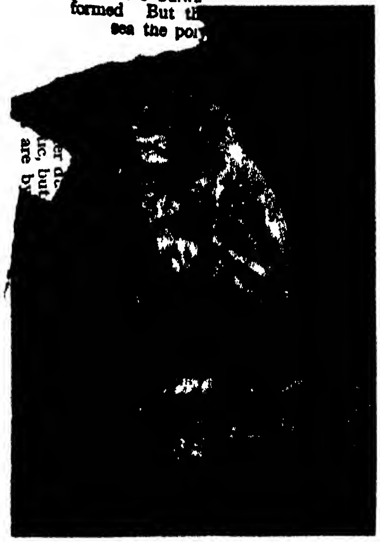
SKUA GULL STEALING PENGUIN'S EGGS: YOUNG RAZORBILLS RESTING

On land the worst enemy of the penguin is the skua gull, which seems to have been created especially to help in keeping down the penguin population. The skua not only makes off with the eggs, but swoops down on the young birds also This photograph (bottom) is from a cinematograph film and shows a skua alighting on a temporarily deserted nest. The penguins make no attempt beyond screaming to defend their young. On the other hand, the gulls do not attack adults The top photograph shows a colony of young razorbills at rest.

Ivory Gull

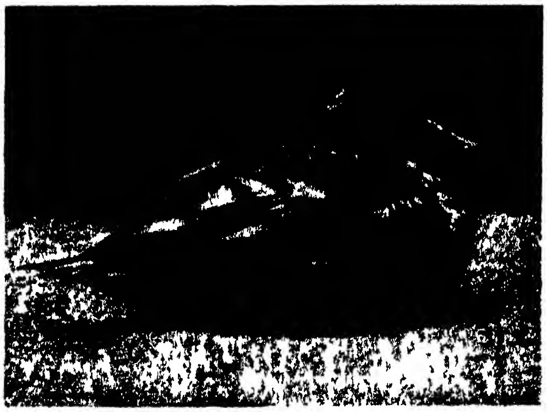
Antarctic Skua



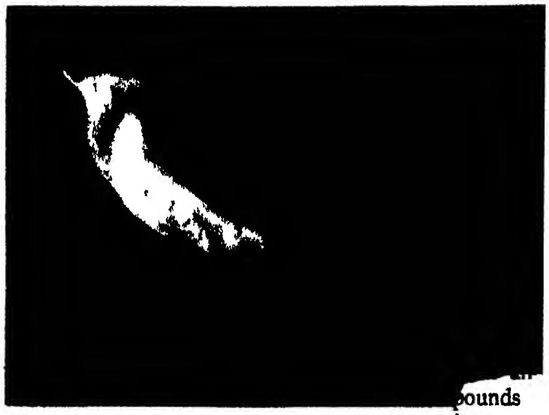
Snowy Owl

Little Auk

Puffin



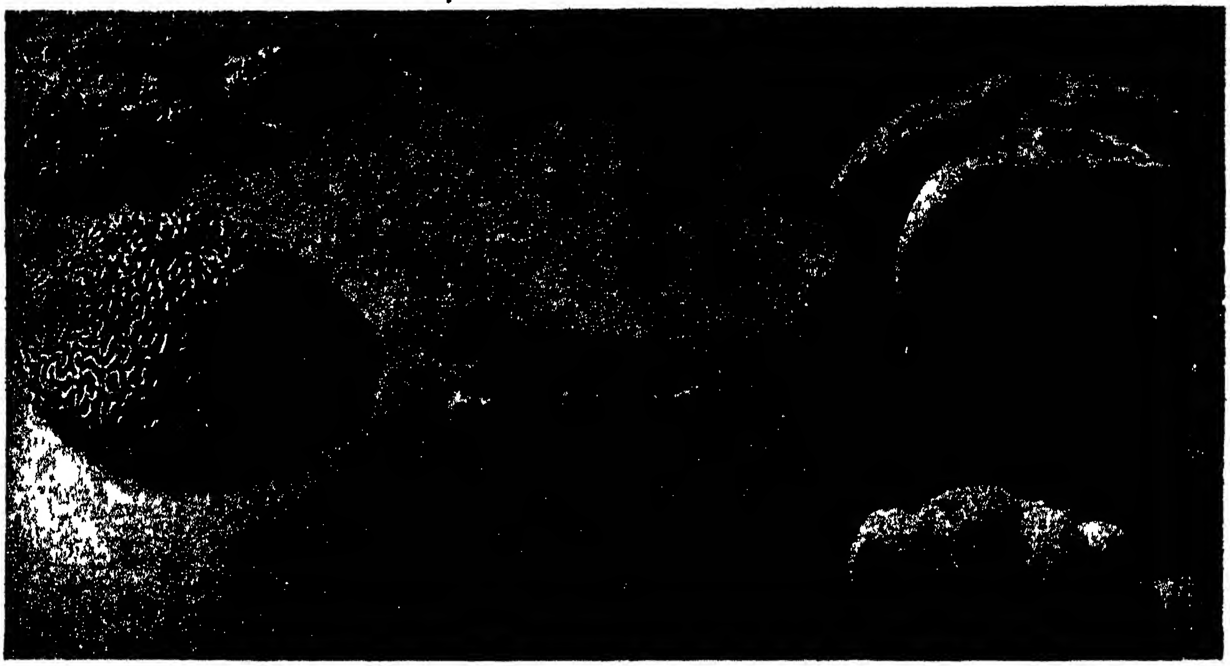
Eider-duck

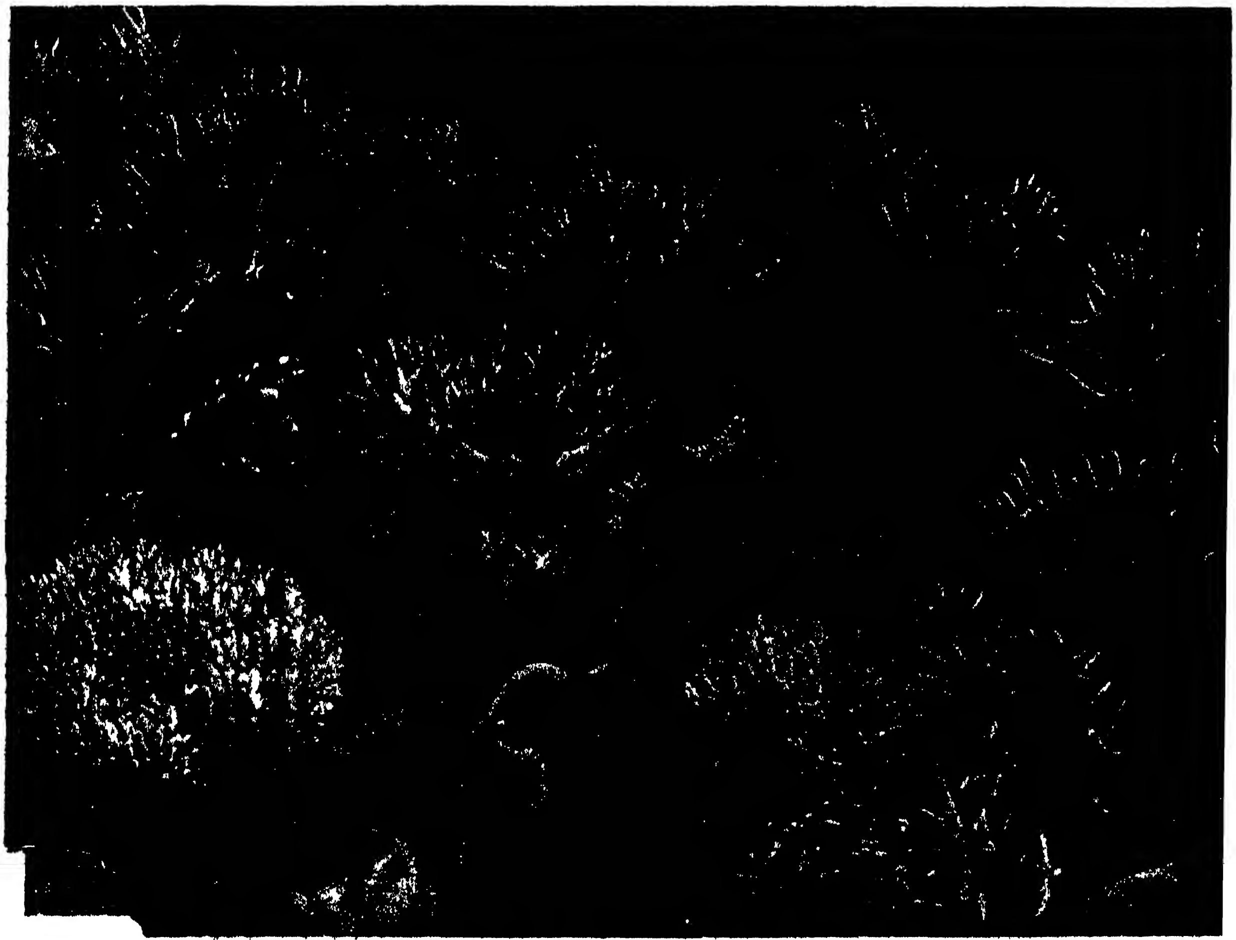


Arctic Skua

BIRDS THAT SWIM AND FLY WITHIN THE POLAR REGIONS

The Arctic has a far greater variety of fauna than the Antarctic The eider-duck builds its nest of seaweed, and the female gradually lines her nest with the down from her body About six nests yield a pound of eider-down Both the eid gull are Arctic. Skua gulls are found in both Arctic and Antarctic The snowy owl is distributed all over the Arc as far south as Scotland Puffins and little auks are among the most numerous of Arctic birds The photograph





W Saville-Kent

BLEACHED CORAL AND ISOLATED GROWTHS OF QUEENSLAND WATERS

On land the worst ...mmunity-dwelling and a common cemetery in one. Each of the little polyps that are the inhabitants builds itself a
population The s... ...ge of carbonate of lime extracted from the sea. By the multiplication of these lime skeletons the mass of coral is
cinematograph film a... can only thrive in certain temperatures and at certain depths. If the coral mass rises above the level of the
their young. Ot... leaving the coral skeletons (bottom) bleached by the sun. Above are some dead growths on Thursday Island.

Chapter XXXIII

Life in a Submarine World of Colour

By E. G. Boulenger

Director, The Zoological Society's Aquarium

Coral is associated in the minds of most of us with tropical seas of dazzling blue bespangled with romantic fairy-like islands. Whilst it is true that coral reaches its maximum development in tropic and sub-tropic seas, it is not confined to such waters, for immense branching stony corals are dredged from the depths of the North Atlantic, whilst large areas of the water around Iceland are covered with corals that are almost indistinguishable from some of the antler-like forms of the tropical reefs. Even in our own waters corals are not uncommon, though principally of small size and living singly. One of the most popular varieties—the famous red coral—comes from the Mediterranean, where it is fished by drawing tangles of net and rope attached to a wooden frame over the sea bed.

There is still prevalent a general notion that coral is the work of insects, but in reality it is the vacated tenement of a polyp, a creature almost identical with the sea anemone. If an anemone, instead of living stark and unprotected on a rocky basis, built up around itself a rampart of carbonate of lime drawn from the sea water, then we should have a coral. The reefs are built up by countless millions of these "reinforced" anemones, the animals living from a few hours to several weeks, but almost invariably multiplying by laying eggs, budding or "fissure," before they die.

Fissure is the most common method of reproduction. The single polyp divides into two for a distance of rather less than half of its entire length, the result being a sort of Siamese twins, each twin forming around itself a stony bulwark. These twins in their turn subdivide, and so the process continues until the accumulated stony hosts of the polyps raise gigantic masses covering vast areas of the ocean. The newest portion, that is, the most recently-formed section of the coral growth, is naturally exposed to the light and glows with a fairy-like tint. Beneath these dazzling growths are piled the empty homes of polyps that have lived their lives, and the accumulated mass may be brittle to a degree or compressed into granite-like formations that resist the fiercest onslaughts of the waves.

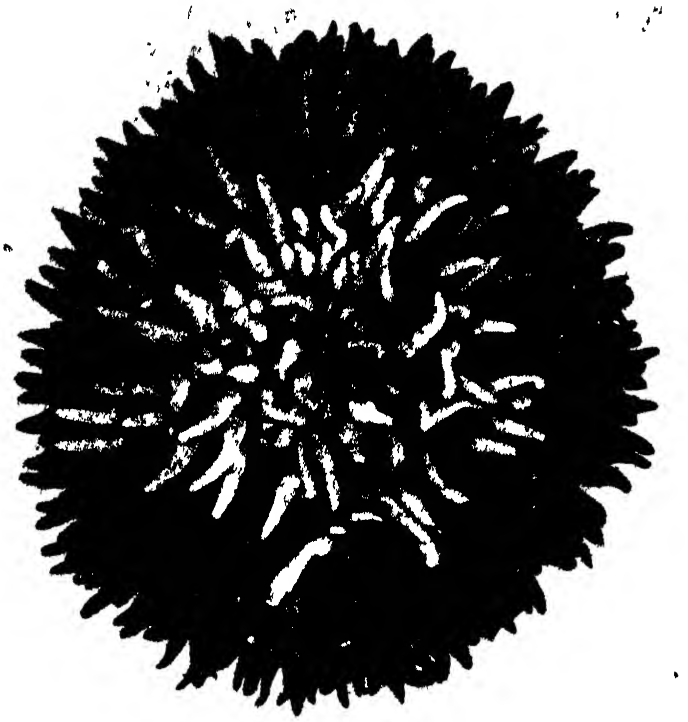
Reefs abound in the Indian Ocean and the warmer waters of the Western Hemisphere. Their size and nature depend on the building material contained in the sea water. It is estimated that in the Pacific a mass of water a million square miles and a thousand fathoms deep contains nearly twenty tons of carbonate of lime. Most tropical seas abound in volcanic islets and submarine mountains that lie just below the surface, and such situations offer ideal anchorage for the nucleus of a coral colony. Nothing in the sea is stable for any lengthy period, for constant uprising or subsidence of the sea floor is taking place. Sometimes a large portion of a continent, its shore heavily fringed with coral growths, slowly subsides, leaving the coral as a barrier reef. Again, the crown of a subaqueous mountain may collapse as the result of volcanic disturbance, and the coral thus left remains as a ring. The resulting lagoon formed by the circular wall silts up and presently acquires a growth of palms and other herbage, and may become a fringing reef encircling a tiny islet.

Such are the vast coral formations which have exercised man's imagination from early times. Hundreds of species of coral may combine to form a reef, a great galaxy of lovely forms, some caricaturing the foliage of both sea and shore, others soaring skywards in miniature towers and battlements, or making big dome-like structures of intricate sculpture twenty feet or more in girth. That portion of the reef nearest the open sea grows apace, the teeming polyps ever sweeping the water with their multi-coloured tentacles in search of the minute organisms that form their menu.

Mere words can convey no intelligent conception of the variety of colour displayed upon a coral reef. Suffice it to say that the corals of the Barrier Reef have been described as assuming every shade of coloration that is to be seen in the air-breathing world. With regard to form, some are huge branching structures suggestive of flattened branches ten feet in diameter, whilst others suggest giant puff balls, organ pipes, and even human skulls. The prevalence of some special form on each reef has largely influenced the nomenclature of the various masses forming the reef, such as Skull Reef, Bush Reef, Stag's Horn Reef, and the like.

Countless other forms of life find ample sanctuary amongst the coral growths hiding in and beneath them, tunnelling through them or living in the calm and sheltered waters between the coral ramparts and the shore. Recent researches have given us glowing hints at the immense variety of marine forms that make a home in our own chilly waters. In the tropical coral seas they reach a maximum development, dazzling the eye and bewildering the imagination. Of recent years the wonderful coral gardens of Bermuda have been photographed and filmed William Beebe, the American naturalist, has even enjoyed promenades amidst their splendours in an ingenious diving helmet weighing sixty pounds whilst a certain artist has placed the submarine orgy of colour upon record by painting under water with specially prepared pigments and canvas

Columbus was the first to make the world realize the vast avenues of unexplored wealth and beauty which lay waiting for all who could face the vicissitudes



W. Saville-Kent

W. Saville-Kent

CORALS THAT LOOK LIKE FLOWERS

This is how the living coral looks with its tiny inhabitants, the polyps, expanded. The polyps gain their living and build up their skeletons—and these skeletons become massed into a coral reef—by sweeping the sea that flows about them for minute particles The piece of mushroom coral (above) looks like a chrysanthemum while expanded.

and dangers of a long sea voyage. It was not, however, until 1770 that Captain Cook discovered that enormous expanse in the South Seas now known as the Great Barrier Reef of Australia, the largest aggregation of coralline formations in the world. It lies within the territorial jurisdiction of Queensland, extending from Melbourne to well within the tropics, a distance of 1,250 miles. and covering an area of 200,000 square miles. It enjoys a great variety of climatic conditions, tropical and temperate species flourishing within its boundaries. In 1893 it was explored and photographed by Saville-Kent, but even to-day, after over thirty years of continued research by many other workers, it is realized that its vast potentialities have been but very cursorily developed. Oysters, edible and pearl-bearing, shells of every form, coral rock for building material, edible fish, crustaceans, and sea-cucumbers innumerable, these are but a few of the harvests waiting to be systematically developed in the labyrinthine coral pastures of the Great Barrier Reef. Over a thousand species of fish are recorded as making their home there.

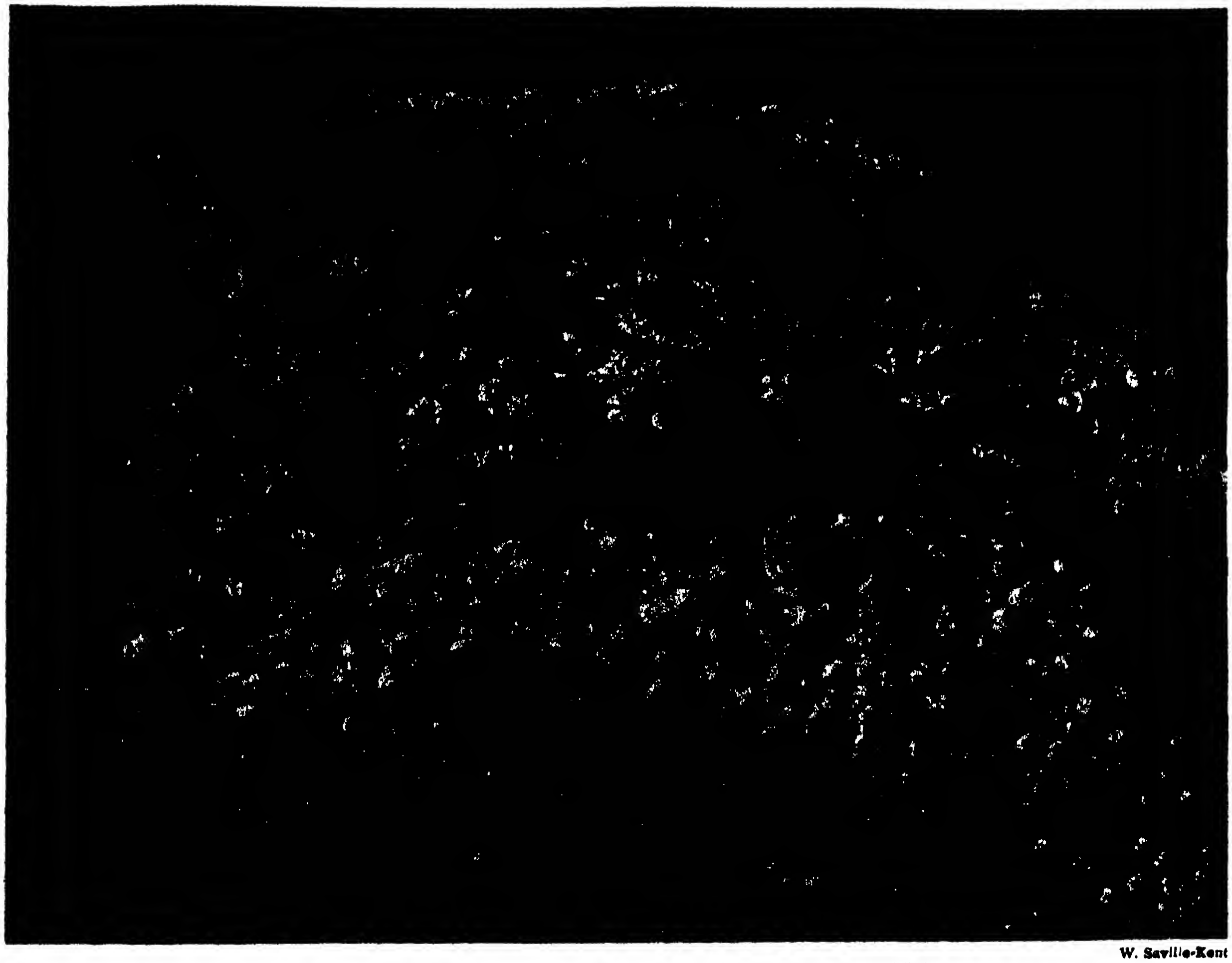
It is sometimes asked whether a coral reef can become "played out," either by storm, volcanic eruption, or the steady whittling away of the coral growth for building material. Such a tendency is, to say the least, remote. Despite the ravages of Nature, the ever-multiplying coral cells are continually being augmented and reinforced by calcareous depositions of lime, shells of molluscs, the exo-skeletons of crustaceans, wind-blown coral sand, etc. The coral on the Barrier Reef flourishes only in such waters as reach a temperature of 68° F. from low tide mark to a depth of rather less than twenty fathoms. Judging by statistics covering the last thirty years, there has been little appreciable diminution or expansion of the principal reefs. Losing ground here, gaining a little there, the coral growths keep more or less within the same limits.

Apart from storm, however, there is a constant levy taken of the polyp cells, numerous bivalve and univalve molluscs tunnelling into the solidest formations. A big sea snail (*Caralyaphilla*) becomes embedded in the coral, but to avoid the penalty of its inertia it continually extends the mouth of its shell till a long worm-like tube of carbonate of lime is evolved, its free end always enjoying communication with the open sea. A coral shell the size of a man's fist may present an extension of its doorway nearly a yard long.

Great clam shells also become embedded in the coral fronds and steadily force them apart. These clams often attain huge proportions, specimens three feet long and weighing several hundredweight being quite abundant. All but concealed in the surrounding coral, they lie with the shells slightly ajar, the animals drinking in various organisms through their siphon pipes. The human foot incautiously entering such a mantrap is held in a grip which only axe and crowbar are able to relax, and numerous deaths are recorded as being directly caused by these clams. Pearl divers, especially, frequently come to grief in this manner.

The pearl and edible oysters of the Barrier Reef frequently settle when young upon the shell of a whelk, and the whelk weighing little over an ounce is presently encumbered with a growth of oysters weighing 10 or 15 lb. Eventually both whelk and its burden settle down into the mud and perish. Pearl oysters were at one time fished by native divers who plunged in naked and remained under water for nearly three minutes. They are now, however, procured by trained divers in up-to-date diving dresses, and as a result some of the beds have been greatly depleted and the culture of artificial or "induced" pearls has become imperative.

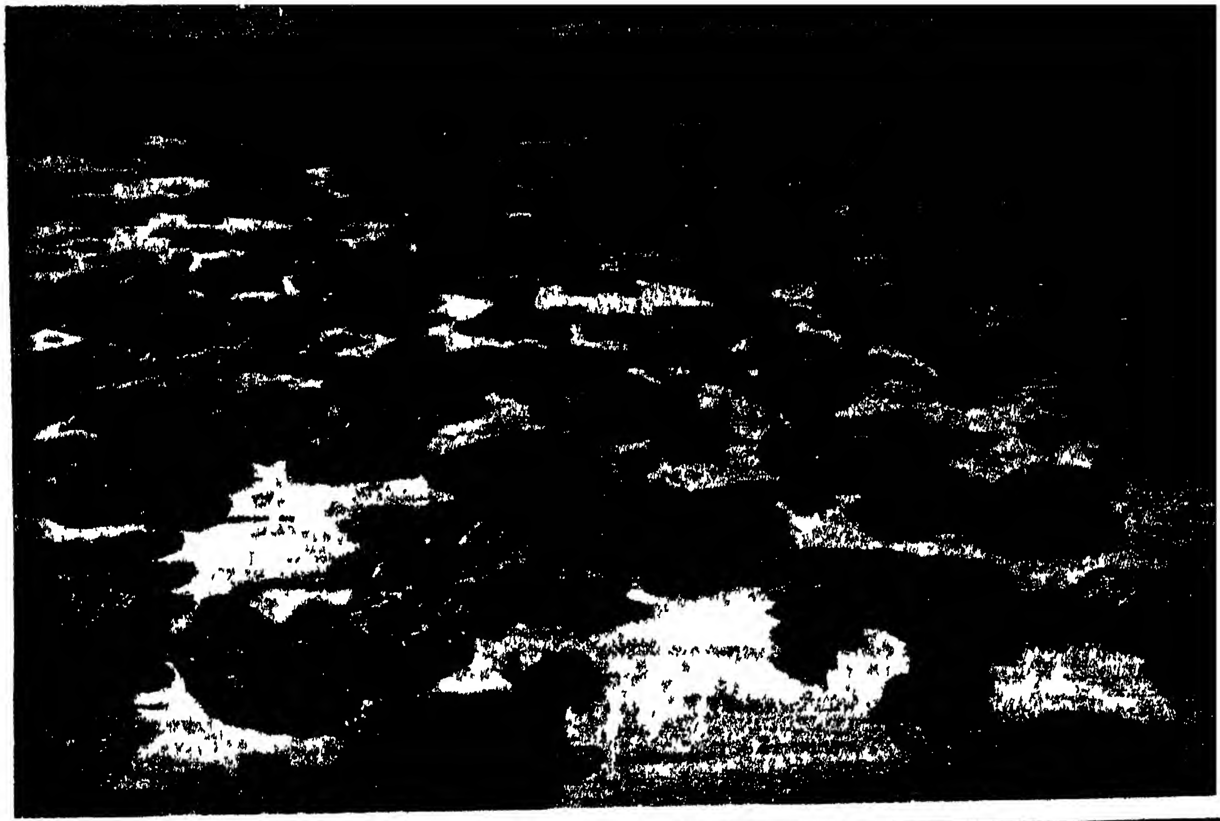
Apart from the damage done by the more sedentary sea beasts, coral is also attacked by all kinds of fish, notably by the gaily coloured file fish, and these actually bite off large pieces of the living coral with their front teeth, which literally amount to a pair of well-sharpened chisels. The varied forms of life which we know on our own shores are multiplied a hundredfold in the tropical coral reefs, the genial climate and abundant food supply inducing a maximum of development. Just as the more northern sea animals tend to resemble and take on the hues of the weeds, mud and gravel forming their surroundings, so do the creatures of the reefs tend to harmonise with the vivid forms of the corals, and nowhere is this more evident than amongst the sea anemones. A giant anemone *Discosoma* measures two feet across, its disk swarming with thousands of vividly banded tentacles that present a dazzle pattern of alternating



W. Saville-Kent

ORGAN-PIPE CORAL WITH ITS POLYPS EXPANDED

Polyps, the living inhabitants of the coral whose skeletons may wreck a tall ship or form a lady's necklace, have short lives, varying from a few hours to a few weeks. They resemble, and are closely related to, the sea anemones; but, instead of relying on stinging powers for protection, they have evolved a way of building a skeleton of lime. The organ-pipe coral which we see here has polyps of emerald-green, and in this illustration they are expanded; that is, they are reaching forth from their pink skeletons for food.

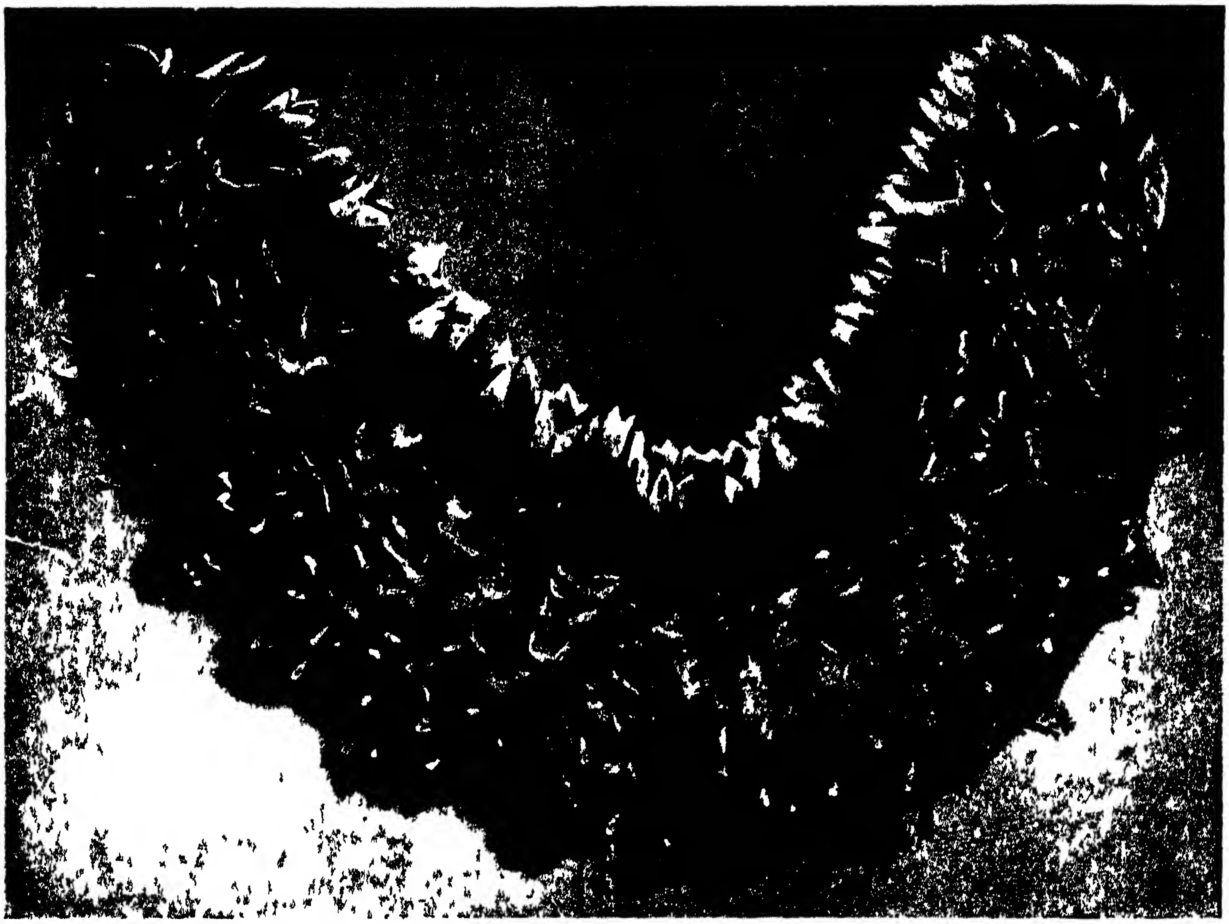


WONDERLAND OF THE CORAL REEF, ABOVE AND BELOW WATER

e most amazing colours dart and flash among the beautifully tinted coral forests. The lower illustration is of a coral garden on the
f off the Queensland coast The brightest shades of blue, scarlet and green, vivid in the sunlight which pervades the clear sea water,
eye on every hand, fish and coral vying in splendour When the tide goes down the reef is exposed (top) and much of the
ishes, the little coral polyps withdrawing within their lime skeletons until the sea covers them again. The photographs by
Hurley on this and the opposite page are reproduced from his book "Pearls and Savages," by courtesy of G. P. Putnam's Sons

STRIPED FISH OF THE REEFS AND THE DEATH-GRIPPING GIANT CLAM

Some fish of the brilliant hues which distinguish the tinted swimmers of the coral reefs may be seen . the Aquarium at the London Zoo The coral reef shows an amazing combination of fish and polyp life which goes to make this subm [illegible] ine world of colour But there are dangers on the reefs. The upper photograph is of a giant clam. This dreadful thing may attain a [illegible] th of four feet At the least touch the serrated jaws shut tight with enough force to snap a man's leg So held, with a horribly crushed [illegible] b, the victim can only be saved by crowbars from a slow death either from exposure on the lonely reef or from drowning when the tide comes in



W Saville Kent

STRANGE PRICKLY FISH OF THE GREAT BARRIER REEF

The sea slugs, known to commerce as bêche-de-mer or trepang, are allied to the starfish and, like them, move by means of a great number of tiny tubular organs which end in discs and exert suction on the surface traversed by the creature The red prickly fish is one of a number of different kinds of bêche-de-mer, and of great commercial value. It is found to grow to a length of four feet, and feeds on minute organisms, called foraminifera, by sweeping a bunch of tentacles over the surface of the reef and stuffing the "catch" into its mouth.

red and golden stripes which harmonise with the surrounding corals. In constant attendance upon these large invertebrates are numerous small fish (*Amphiprion*) which actually take shelter within the stomach of their host and appear to be quite inured to the monster's stinging properties.

Many theories are offered as an explanation of the strange co-partnership. It is possible that the small fish enjoy the monster's protection and are tolerated, since they lure to within reach of its arms fish larger than themselves The latter are at once caught, paralysed, and engulfed. The little fish invariably bolts for cover into the anemone's interior upon alarm, and a stick thrust into the stomach cavity usually results in dislodging a number of *Amphiprion*, even if none are actually in evidence It is usual to obtain these fish for aquarium exhibition by employing divers who bring up the anemones, disinterring the fish when safely on board.

A small prawn is also associated with this anemone and, like the fish, is banded cream and orange with touches of blue or black to harmonise with its host. Starfish and sea urchins innumerable glide and scramble amongst the piled terraces of the coral growths, gardens of delight clearly visible to the naked eye through several fathoms of crystal water.

Most abundant of all are the sea-cucumbers, of which many scores of species are found on the Barrier Reef. The edible sea-cucumber known as trepang or bêche-de-mer is gathered by natives into sacks at low tide. A live bêche-de-mer may stretch to four feet in length, a gorgeously decorated and sluggishly animated sausage. After being boiled for twenty minutes, cleaned, gutted, dried in the sun and subjected to twenty-four hours' further drying in a shed filled with wood smoke, it is still sausage-shaped but shrunken to six or eight inches and of a somewhat charred appearance. In this form it is exported to the markets of the world, even finding its way at length to the Oriental restaurants of England. It is stewed into a soup rich and glutinous and ranks next to the pearl industry as the greatest source of revenue of the coral islanders.

To the naturalist and artist the giant sea-cucumber must appeal no less than to the Oriental gourmet.

Expanded, the creature's cylindrical bulk glows with the richest tints. The body, apart from the hundreds of tube feet on which the animal walks, is beset with thickets of tapering protuberances marvellously spotted, striped, or banded with olive green, mauve and gold to blend with the ramifications of the corals or the chequered pattern of the shells. The head end expands at feeding time—and feeding time is almost continuous—into a crown of delicately cut tentacles that sweep the surrounding water for the minute growths on which the creature feeds. At the same time the tentacles ward off many a foe by their superficial resemblance to the sting-celled plumes of the anemones.

These sea-cucumbers swarm on every portion of the reef. Some hunt the sea floor where they burrow into the sand and coral refuse, others twine amongst the branching stems where they mimic stony fronds. A few species even imitate sea snakes for the sake of protecting themselves, one large specimen being able to stretch to nearly ten feet in length.

In conclusion, the Barrier Reef has stood for thousands of years, and is likely to stand for many thousands more. Man during his short sojourn on earth has decimated the wild mammals, and has gone far to exterminate the birds and even the reptiles. The treasures of the sea, on the other hand, whilst exciting the utmost avarice, are safeguarded by one all-important factor—the sea itself.

One factor alone threatens the existence of this subaqueous fairy land, and that is climate. Such a menace is not likely to be appreciated in the lifetime of the reader, but the possibility nevertheless does exist, for the rocks bear ample testimony by the fossils they contain to the fact that coral reefs must have at one time existed where now is dry land.

Coral can only flourish at certain depths and in certain temperatures. The geologic history of the earth, compared with which the history of man is but as yesterday, shows that ocean and continent have more than once changed places. Of course, any such change would vitally involve ourselves as well as the coral. But that is another story.

W. Saville-Kent

FOR GOURMETS OF THE EAST: SEA-SLUG OR BECHE-DE-MER

From the earliest times certain forms of sea-slugs have been esteemed great delicacies in Malaya and China. The Portuguese christened the creature bicho-do-mar, worm of the sea, and the French adopted the name and made it bêche-de-mer. In the East it is called trepang. A four-foot specimen, after boiling, drying and smoking, is only about eight inches long; it is then said to make a very pleasing soup. Trepang fishing ranks next to pearl fishing in importance among the coral islanders.

DOGS THAT HAVE LEARNED TO SERVE THEIR MASTERS' NEED

pride. In the upper picture is a more unusual example of mental activity in
out of its stable for a walk, solemnly leading it by the bridle, the mare following

Chapter XXXIV

Do Animals Reason?

By Frances Pitt

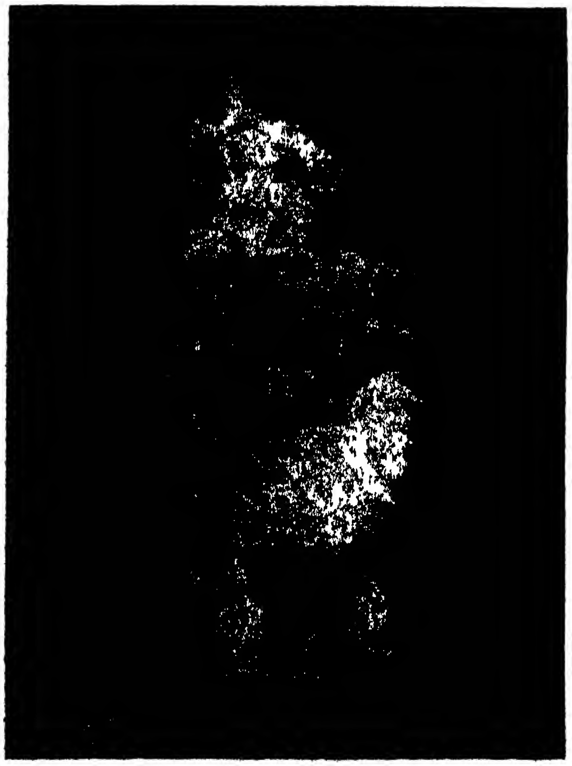
Author of "Animal Mind"

THE first thing in considering the question, "Do animals reason?" is what do we mean by that much abused and much misused word "reason"? Well, I am using it to signify the mental process that results in intelligent behaviour, wherein a being exhibits judgement and purpose and a practical ability to shape its actions to achieve a preconceived and desired end, in contrast to instinctive behaviour, when an animal is driven by blind impulse, arising from an hereditary reaction of the nervous system to a particular stimulus, or series of stimuli, towards an unknown goal.

With regard to animals it is often extraordinarily difficult to know when they are acting from impulse, and when with considered judgement, and observers differ very much in what they attribute to those inherited modes of action we term instinct, and what to an intelligent understanding, but I will give some examples of behaviour that I consider show the working of mind.

Here is the first. I have two tame otters (the otter is an animal of very keen mentality, second, in my opinion, only to the dog in the matter of intelligence) and one of them, the female, Madame Moses by name, was swimming across a pool bearing a mouthful of grass with which to make up her bed, when I called her. On hearing her name, Moses swung round to come to me, then hesitated, turned about, went on, deposited the grass in her sleeping box, and then swam back to me. As a rule she rushes to me the moment she hears my voice, and in this instance the conflict between her desire to come to me at once, and to carry on with her job was most apparent. No one seeing the way she went and deposited the load, and then came back could have doubted that her actions were animated by purpose.

It is the same throughout the long scale of animal life. The careful observer sees even quite lowly creatures performing actions that seem to betoken memory and purpose, as when fish accustomed to be fed at a certain hour at a certain place duly appear at feeding-time; but the higher one ascends the scale, the more obvious do these signs become, until in the apes we find a really enquiring mind.



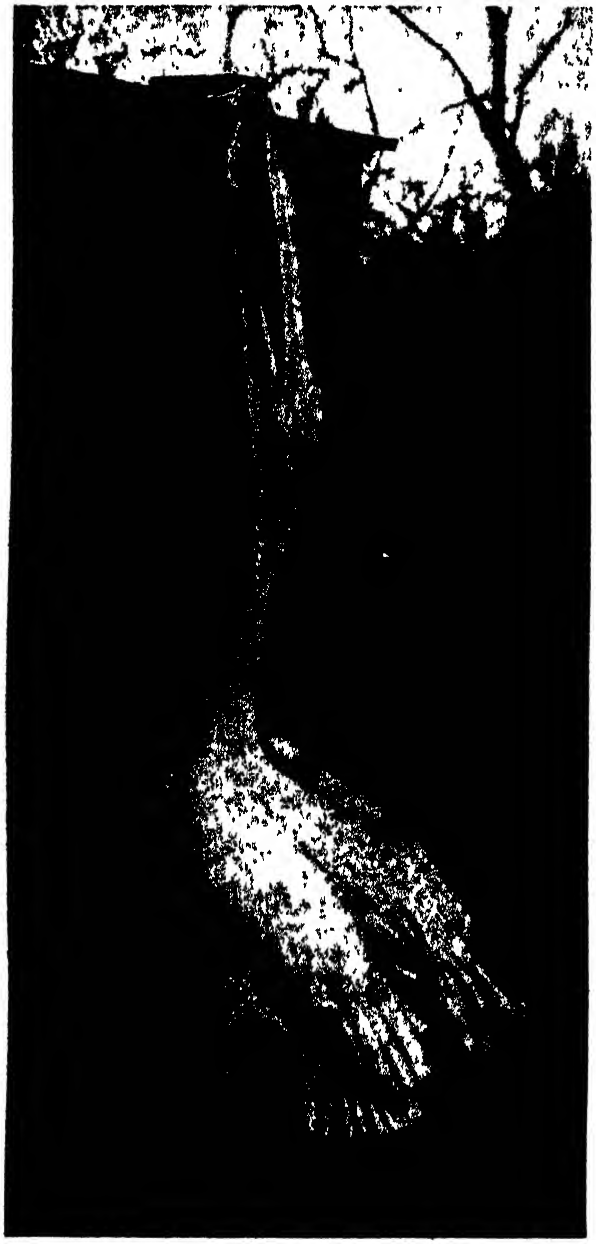
HUNGER AND EXPERIENCE

This West Highland white terrier knows that if it eats the sugar before the permission is given, trouble is likely to follow. But whether it is reasoning about the matter as it sits there is a question which is not at all easy to answer

Professor Köhler made a most thorough and painstaking investigation of the mental ability of the chimpanzee, with some illuminating results. He kept a number of young animals under observation and tried numerous experiments upon them. In one experiment food was placed outside, and some little distance away from, the cage, the ape inside being furnished with several pieces of bamboo rod. Not one of these was long enough to reach the food, but Sultan, one of the apes, found that by putting a thin stick into the hollow end of a bigger bamboo he could make an implement long enough to reach the food, and then proceeded to rake it in. Ever after the ape remembered how to make himself a stick of the desired length, and always did it to reach ungetatable food. Professor Köhler thought his first fitting of the sticks together was accidental rather than thoughtful, but emphasises how quickly the chimpanzee appreciated the importance of his discovery, and that he later made three-length poles to reach to a distance.

These chimpanzees also displayed considerable ability in building, putting boxes one on another so as to make an erection upon which they could climb to reach fruit hung from the roof of the cage; and did a hundred and one smaller things that showed their intelligence, from teasing each other, and human beings, to teasing the fowls. In the latter case, as Köhler explains, the hens were lured near the apes' pen by scattering crumbs of bread through the wire, and when they began to pick the crumbs up an expectant ape poked them through the netting with a stick.

Does not all this show an understanding, an impish mischievous spirit, far removed from the blind impulses of instinct?



Keystone

THE PELICAN'S STOCKING

At Christmas someone presented a stocking full of delicacies to one of the Zoo pelicans, but, for the sake of testing the bird's intelligence, put it out of ordinary reach. But the wise bird made very good use of a long neck and beak, as we see.

But the anthropoid apes stand so high in the scale of life that some hint of practical judgement is merely what we should expect; what about other animals, the elephant for instance? Here we have a creature long reputed to be of exceptional sagacity, and for once popular story does not belie the animal's intelligence. The care with which it tests each step before crossing boggy, doubtful ground, or venturing upon a planked way, is well known; and I have witnessed retaliation by an elephant which showed its appreciation of a situation. This was in the London Zoological Gardens, and here is the little history as I related it in my book "Animal Mind."

Two soldiers were offering one of the elephants, standing in its stall in the elephant house, a bun. They held the bun out, but when the elephant passed its trunk through the bars and tried to reach it they drew the bun back again, which was repeated several times. The boys—for, despite their uniforms, they were little more—laughed hugely, especially when the elephant turned away as if in disgust. It crossed its stall to where, in the corner, there was a water tap, from which water was slowly dripping. Putting its trunk to this it stood and waited, collecting the trickling drops. The two soldiers were still there, with the bun, when the elephant swung round, walked back to the bars and blew the contents of its trunk over them! The water went into their ears and eyes, and down their necks! The elephant stood swaying its trunk and watching them as they decamped.

If that episode did not show thought and judgement, what can you bring forward as evidence?

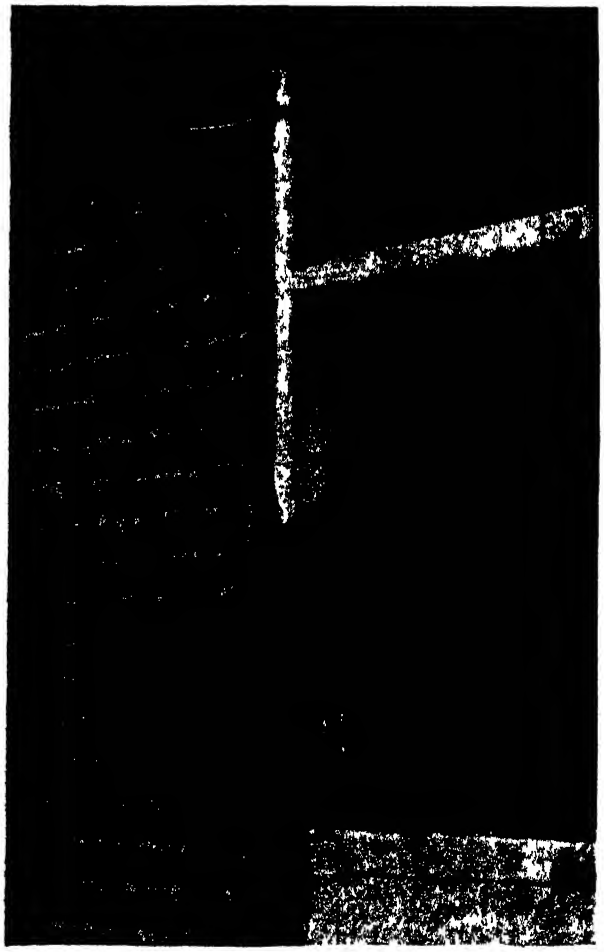
In my opinion revenge is the best evidence for memory and of comprehension of cause and effect. Peafowl are not usually credited with being "brainy" birds, yet not long ago I saw a peahen revenge herself most deliberately on a farmyard cock. She was feeding quietly, when the cock, a young and pugnacious bird, came up behind her and knocked her over. She picked herself up, and turned upon him. The cockerel ran, but she ran after him, gave him a good drubbing, and when he ran off, pursued him once more. She chased him and beat him for over an hour, until they were parted, and the cock took the opportunity to slip into hiding. He was a Light Sussex cock, and there were four or five other cocks so like him it was difficult to tell them apart. Yet the next day, Jane, the peahen, unerringly selected the right bird, and proceeded to administer further punishment, which she did most thoroughly!

THE raven is, of course, well known to be a bird of exceptional intelligence, yet when experimenting with Old Joe, my pet raven, I hardly expected the retribution which quickly befell me. To test his power of discrimination I took some butter on the tip of my finger and held it out to him. Joe took it with gusto, and scraped every atom from my finger, using his powerful beak with exceeding gentleness. Then I took a piece of soap, of the same size and colour, and offered him that. He looked at it, but did not touch it, though next second I had received such a punishing stab in the finger from his iron bill that I shall never forget it! I can only say I was quite satisfied with his power of discrimination.

Definite evidence of memory extending over any length of time (and memory is the frame on which experience is reared, whence judgement draws its material) is difficult to find. For, though popular anecdotes are many, carefully-observed facts are few; but here *is* concrete and incontrovertible evidence concerning Madame Moses, my otter.

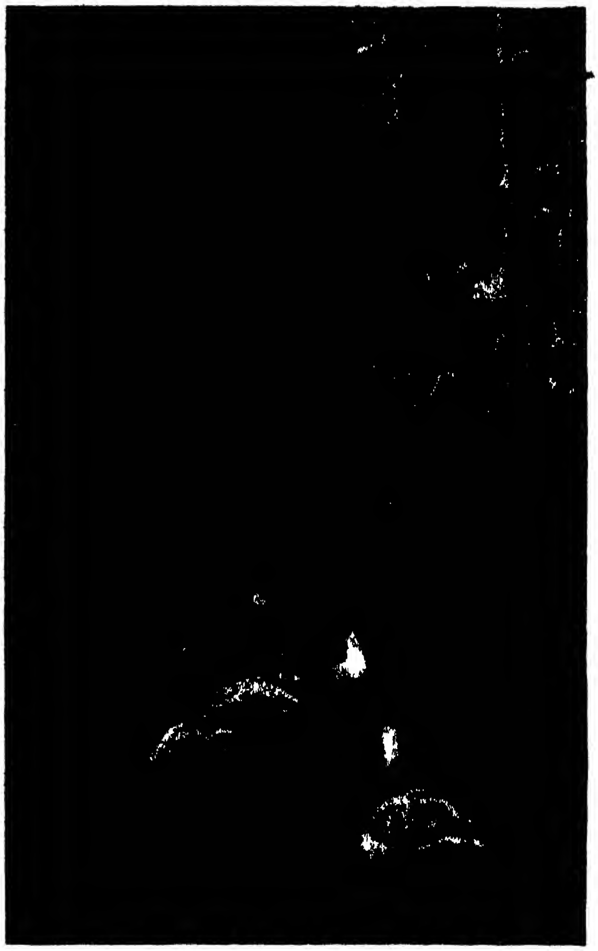
About the otter's enclosure is a high fence, on the top of which I put a white card with a long string dangling from it. I let Moses see me put some food on the card and waited to see what she would do about it. She tried to reach the card, which she could not do, then seized the string with her teeth and tugged it, whereupon the card came down and she got the food. Thereafter she was quick and clever at pulling things down by strings. But from January 20 to August 6, she never saw a card, or anything resembling one. On the latter date, Moses being asleep in her kennel, I put a white card with dangling cord upon the fence, then went and roused the otter, but did nothing to draw her attention to the card. Yet in a moment or two she caught sight of it, trotted to the place, took the string in her mouth, and deliberately pulled the card down. After a period of over six months she instantly recognized the card and remembered how to get it off the fence.

The return of a dog for a buried bone, and of a fox for the prey it has also buried, may be cited as



AT THE STABLE BELL

Horses are by no means the most intelligent of the domestic animals, but this one learned to associate meal times with pulling the cord of a bell outside its stable, and was thus able to attract the attention of the stableman.

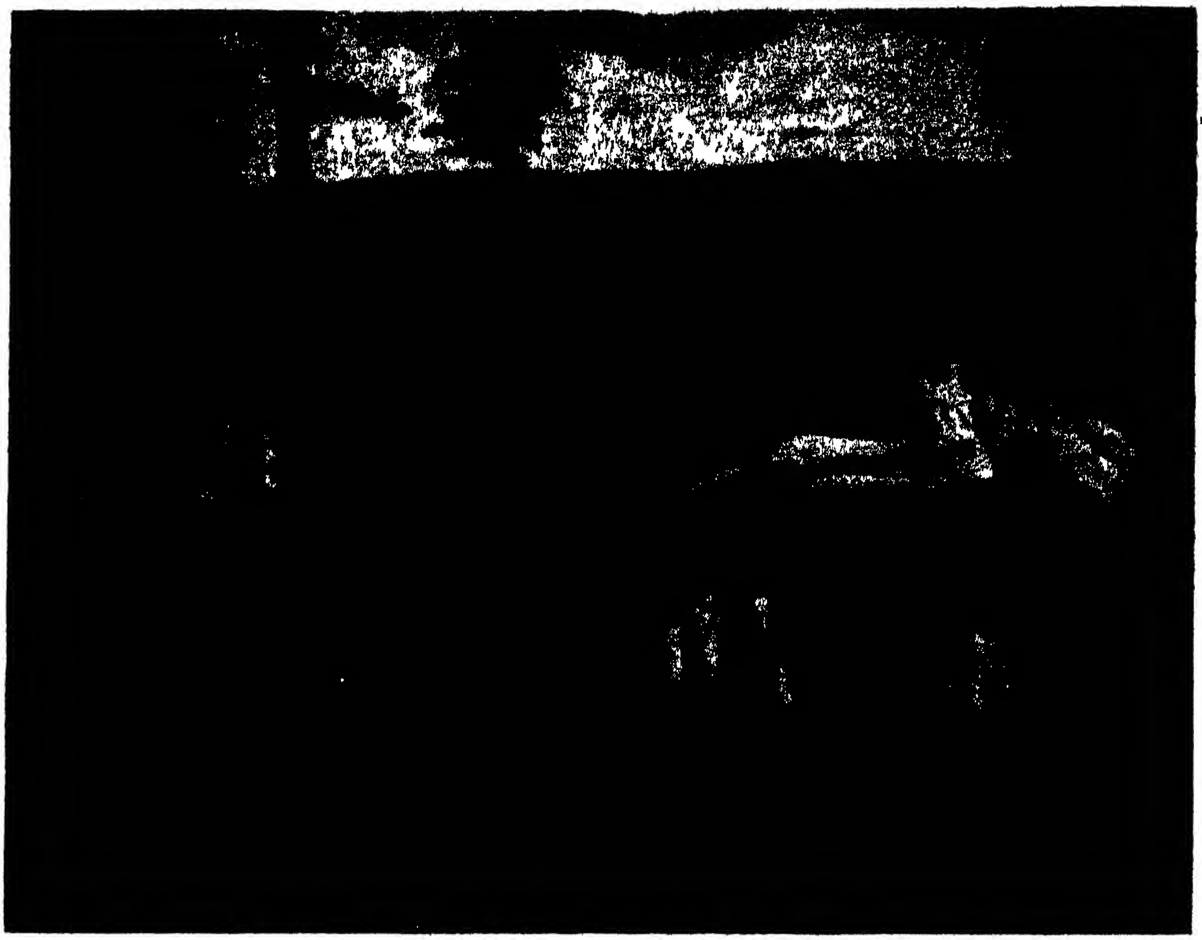


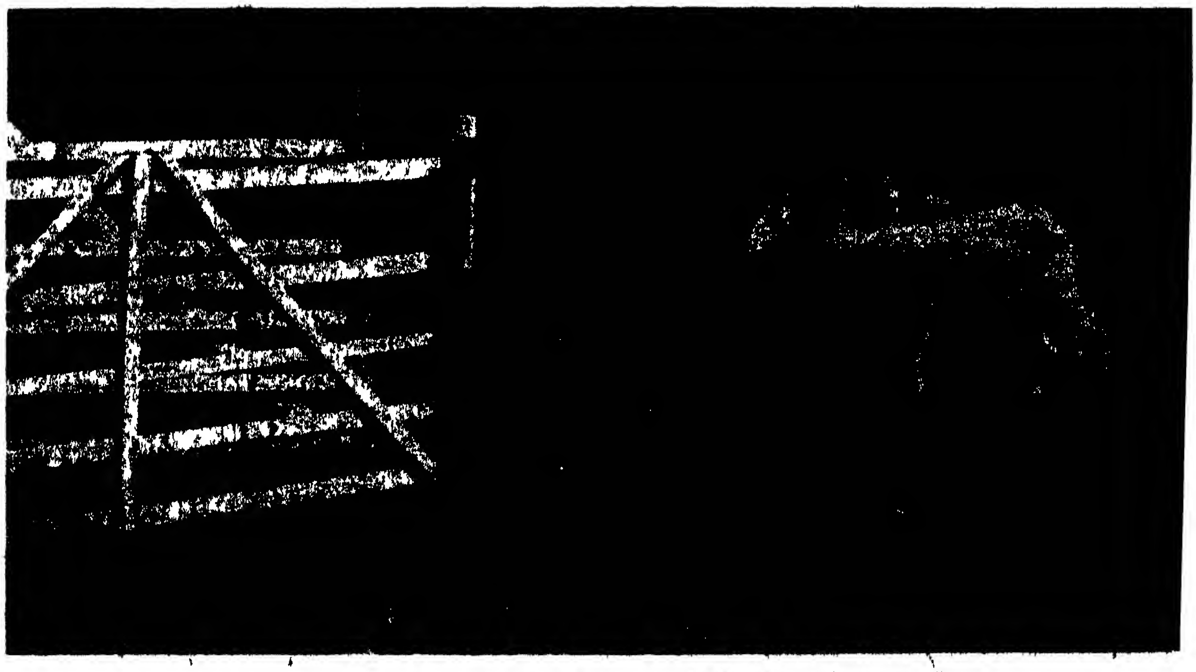
SWANS RING FOR MEALS

At Bishop's Palace Mere, Wells, there are swans that swim up to a string which rings a bell when they feel meal time coming on. Notice that it is a cygnet that is doing this, the young bird having already learned from its parents.

proof of memory, which brings us to the difficulty of telling where intelligence ends and instinct begins, or to put it the other way about, where instinct ends and judgement begins. Animal behaviour is a varying blend of inherited aptitude (varying from a definite mechanical response to a stimulus up to a vague inclination to behave in a certain way under certain circumstances) and intelligent adaptation.

For example, the tendency displayed by dog and fox to bury unwanted food is clearly instinctive, and independent of experience. This does not affect the fact that the return to the cache is at the dictates of memory. But referring to the young animal's early efforts, I have seen a hand-reared fox-cub, who had never known what it was to be short of food, take a rabbit's leg to the tray of sand in the corner of the room where she was kept, and bury it, scratching a hole, dropping the bone into it, and pushing the soil back with her nose: I have also seen a small puppy snatch an apple from her playfellow, rush into a corner, and try to bury it in an old sack that lay there, going through all the appropriate actions





WONDERFUL REASONING POWERS OF THE SHEEP-DOG DISPLAYED

At the sheep-dog trials the most impressive examples of canine intelligence are displayed. For the dog must, to a certain extent, act on its own initiative in certain circumstances, besides being marvellously under the control of the shepherd. Below we see some sheep being penned by a dog at the Tring Agricultural Show, and, above, a Border collie marking down a sheep to separate it from the rest. The shepherd says nothing, but only blows a whistle or motions with his hand.

J W Henderson

COUNTING AND PICKING OUT NUMBERS

In the upper photograph a dog is confronted by a row of numbered plates turned upside down. The dog turns over the plates until it gets to the particular number which its master has selected. Below is a pony which is said to be able to count up to eight. Whether or not the element of reason is really displayed in these two cases is certainly arguable, but perhaps the sceptics are as liable to err quite as much on one side as the animal lovers do, through affectionate partiality, on the other.

HEREDITY AND EDUCATION COMBINED: THE RETRIEVER

Charles Reid

Retriever pups display a desire to pick up things and carry them, but there is a great difference between these manifestations of heredity and the behaviour of the finished dog when out with the guns. A long and painstaking education develops something already in the animal so that it shall know when a certain action—the picking up of a bird—is right and when the same thing is wrong. This is a retriever with a hare. Long years of careful breeding have, of course, been responsible for the retriever's intelligence.

for interring it in the earth. In each case the impulse was clearly independent of experience, and we can hardly believe that either puppy or cub thought out beforehand what it was going to do.

YET a great deal of behaviour which is usually described as instinctive is nothing of the sort. Take the case of a song thrush beating a house snail to pieces upon a stone so as to be able to extract the creature's luscious body—how does the thrush know the way to deal with the snail? Does it know instinctively? To test this I hand-reared a young thrush, and when Jack was full grown and able to deal with any sort of food, offered him several snails. He showed no signs of understanding what they were. When they began to crawl about he took notice of them, inspected them closely, and pecked their waving antennae, but when they immediately withdrew he lost interest, and so it went on for a week. Each day I showed him snails, and his inquisitiveness grew. But the disappearance of a snail into its shell mystified him completely. On the sixth day he appeared to lose patience. A snail drew back into its house, he turned the shell over and could not find it, so he picked it up by the lip of the shell, and gave it a swinging thump on the ground, treating it as he would have done any unmanageable food.

The thrush always beats a worm or grub it cannot easily dispose of, and it was clearly this tendency that made Jack hammer the snail on the ground. It rolled from his grasp, but he picked it up again, and jumping on one of the stones I had put ready for him—an experienced thrush stands before his "anvil," not *on* it—thumped the snail repeatedly.

However, he had not yet acquired the art of cracking it, and it was not until the next day that he broke open his first snail, when exasperation led him to beat a snail so hard that it *did* break. After that he knew how to deal with snails, and gradually became as expert at dealing with them as any song-thrush you see smashing a snail upon its roadside "anvil." It is noteworthy that a thrush resorts to a good stone for weeks on end, and a well-used anvil will be surrounded by broken snail shells. Watching my thrush led me to the conclusion that the snail-breaking habit of the thrush was not an inherited instinct, but the result of experience superimposed on the truly instinctive aptitude to beat unmanageable food.

Again, to take a familiar instance of the combination of an hereditary tendency and education, there is the retriever. The breed is distinguished by the pleasure it takes in picking up and carrying things. Quite young puppies have the inclination. It is part of their hereditary make-up, just as the tendency to gallop round a flock of sheep is part of the mental inheritance of the sheep-dog, but there is a very wide gap, only bridged by long and careful education, between the inexperienced puppy and the finished retriever, who sits motionless by his master at a shoot, noting where each bird falls, ready, at the word of command, to go forth, pick it up, and bring it back.

THE finished retriever is a dog of experienced judgement, and it is this profiting by lessons and experience which makes him, likewise the elephant that has learnt its business as a timber carrier, or in any other capacity, such a valued servant of man.

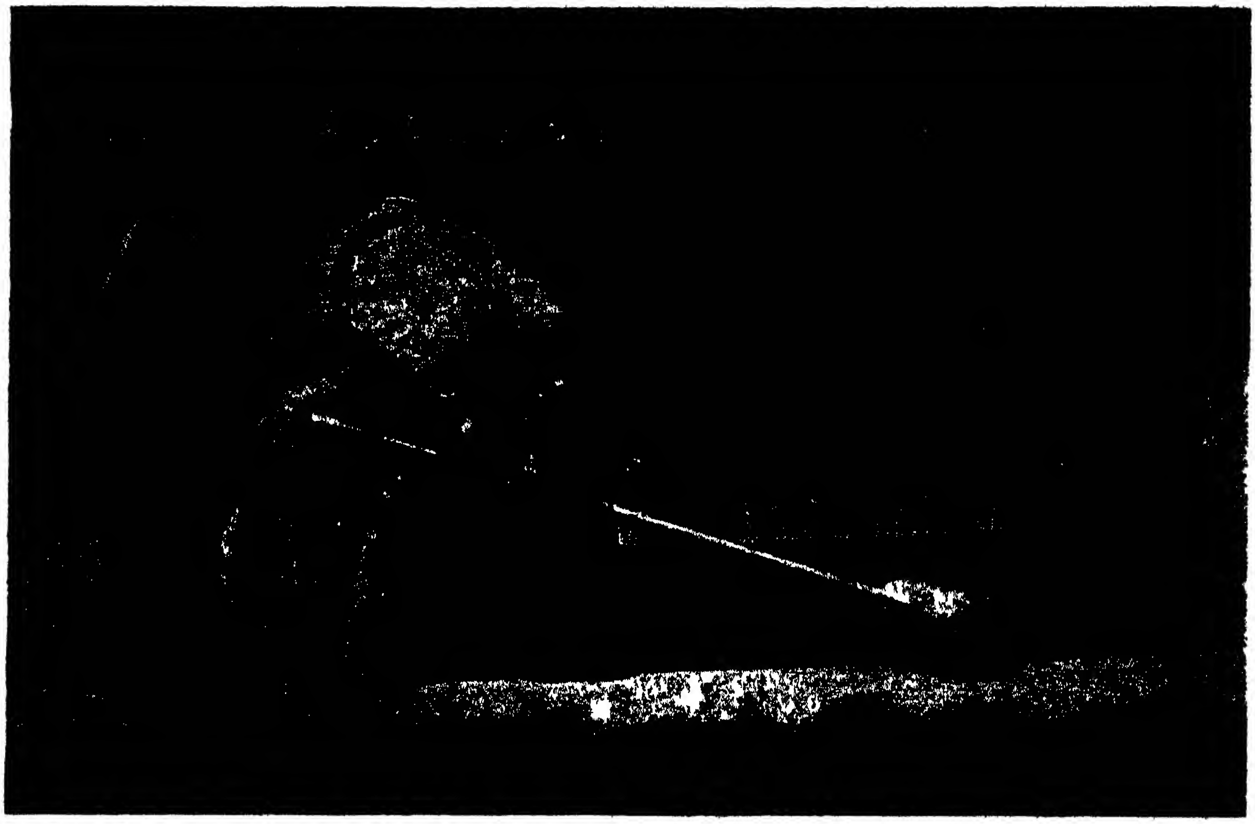
Now, to turn to another aspect of animal behaviour, can we find any cases of co operation which will supply us with evidence of reasoning power? The many stories of rats assisting each other to drag off eggs will at once leap to the mind, but in the absence of well-attested evidence from a competent observer —most of these stories are too much of the "yarn" variety—I prefer to turn to what I have seen myself, when two tame ravens *did* co-operate to tease a cat, one taking her attention by hopping about in front of her, while the other crept up behind and tweaked her tail. When the cat sprang about, with an outraged spit, the first one had her, likewise by the tail! So it went on, a merry game for the ravens, if not for the cat; and one showing a keen understanding on the part of the ravens of how to play into each other's hands, or rather, I should say, beaks.

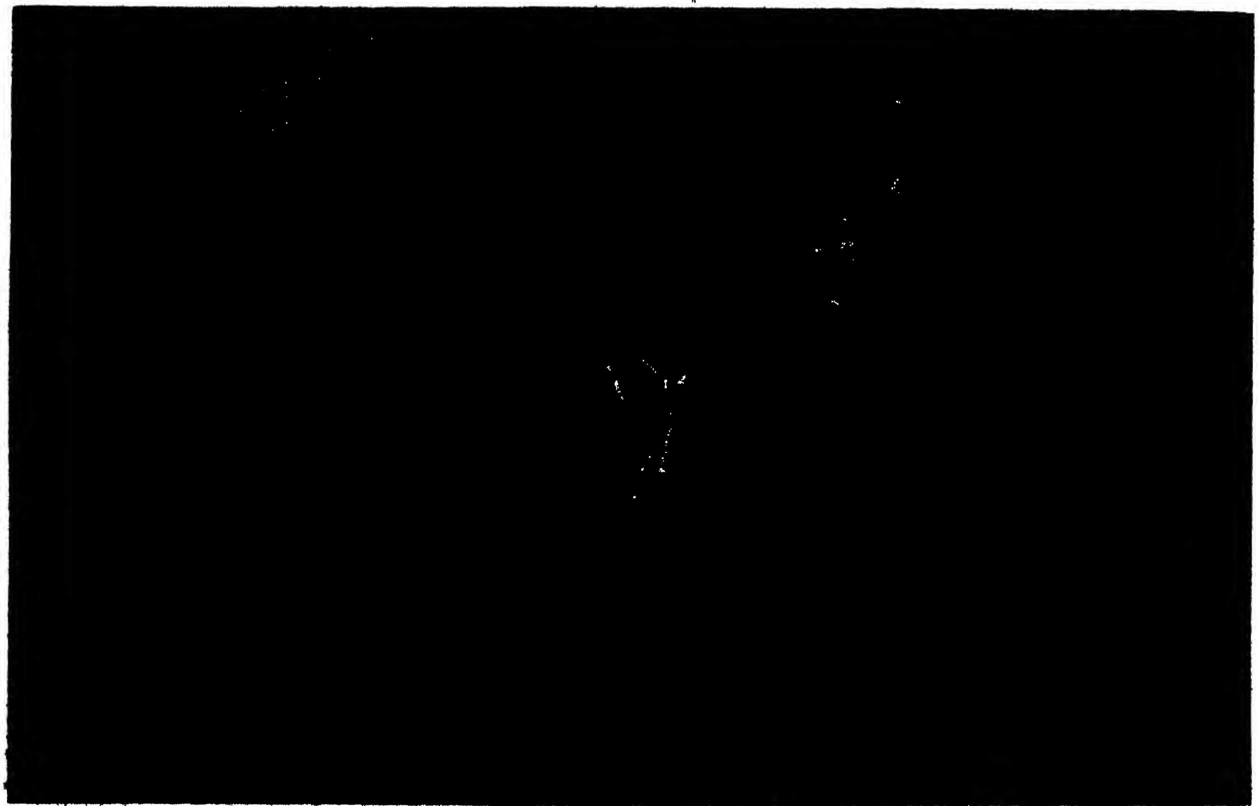
But the most perfect examples of co-operation are to be found among the lower creatures, among the social insects, with their cast-iron instincts, handed down through countless generations, in which each individual is driven along a preordained path, its nervous system responding to the appropriate stimulus in a manner that would seem to leave no room for individuality, or escape from routine behaviour. Yet even here we *do* find evidence of memory, and even of judgement. The bee, the slave driven by her instincts in most respects, has a memory; she learns her way about the country around her home, and if taken outside her usual radius is quite lost.

F. W. Bond

CHIMPANZEES DELIGHT IN IMITATING HUMAN ACTIONS

Exhaustive tests have been made of the intelligence possessed by chimpanzees, the most adaptable of apes to human surroundings and considered to be the most highly intelligent of the ape family. Sometimes the mere desire to "ape" human beings is mistaken for reason. It is to be wondered if the chimpanzee seen above washing his companion over an enamel basin really thought or cared that the process made his friend cleaner. The action with the sponge is certainly human enough.





Gilliams Service

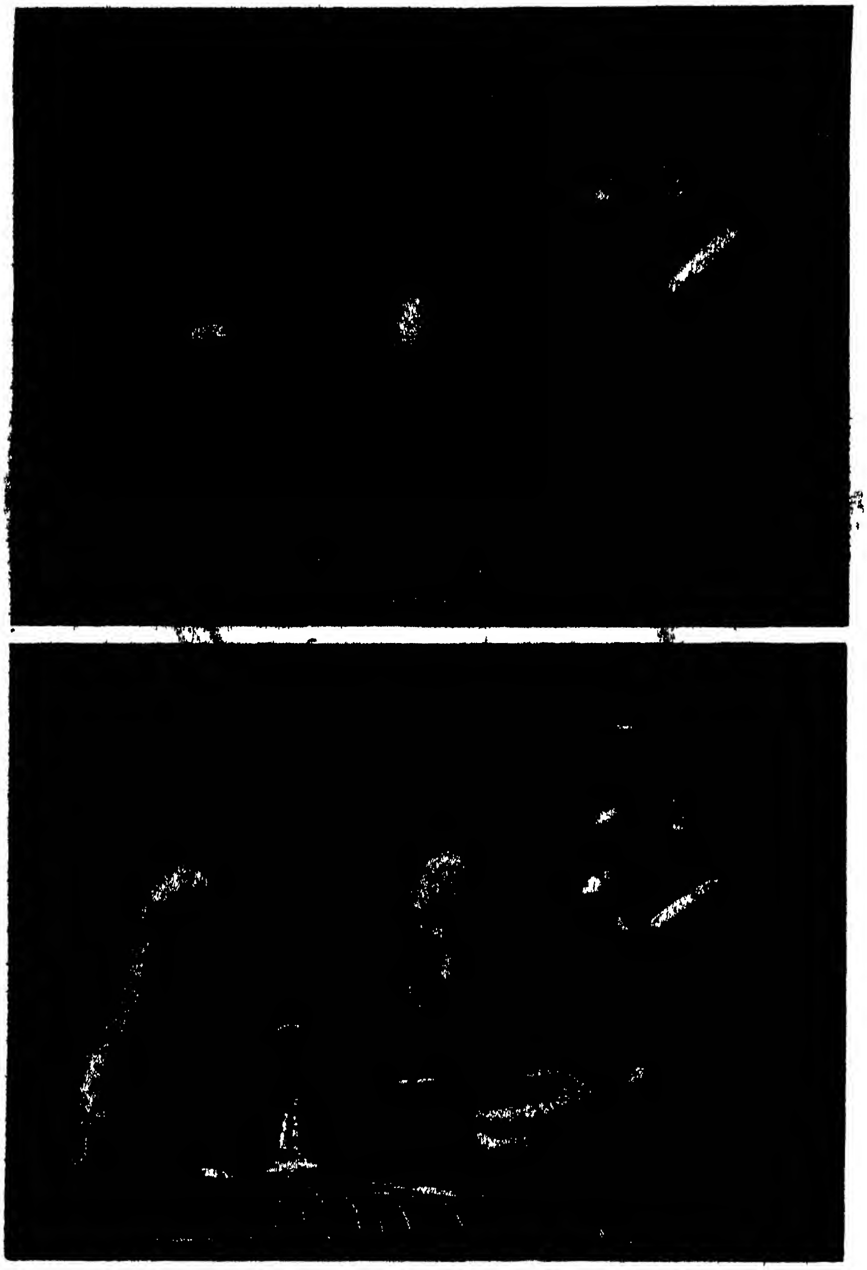
ELEPHANTS DOING UNUSUAL SERVICE FOR THEIR OWNERS

While elephants are known to do certain things well, their possibilities have not been really thoroughly explored. For instance, some enterprising person at Miami Beach, in Florida, the great American seaside resort, has discovered that a young elephant, which is incapable of heavy work, makes a novel caddie on the golf course, and it neither expresses nor implies comments on the player's game. The upper photograph shows another young elephant sweeping diligently outside its shed. With a broom a mature elephant would be an imposing worker

A. H. Willford

THRUSH AND OYSTER-CATCHER THAT HAVE LEARNED FROM EXPERIENCE

Thrushes have learned that snails are good to eat, and are not to be defeated by the awkward shell. Sometimes a stone is discovered that has been used by one of these birds (bottom) for weeks at a time until the ground is littered with broken shells, smashed as upon an anvil. The snail-cracking habit seems to be the result of experience, added to the instinctive habit, possessed by the thrush, of beating any unmanageable food on the ground. The oyster-catcher (top) is seen using its beak as a prop while it settles down on its eggs.



COCKATOO FINDS HOW TO MANAGE A CUP

Having found that there was something good in the cup that was difficult to reach when the cup was getting empty, this knowing bird at last learned to imitate the keeper. Having grasped the handle in its claws—which are, naturally, very well fitted for such an action—the bird was able to tilt up the cup (bottom) and get the utmost out of a long drink

It should, however, be noted, that there is some evidence that ants can communicate news to each other, that an ant will go home to the nest to seek help, and, what is more, she will invariably get it.

This seems clear evidence of communication. Here we see signs of more than mechanical response in creatures so different from us as the insects, while up and down the animal scale we see many instances of considered action, varying in degree of judgement, but displaying an amount of gumption—to use a homely word—widely apart from unconsidered response.

WHICH brings us to the question with which we began this essay, "Do animals reason?" My reply is, it depends on how you employ the word. If you use it to denote the power to form ideas, and pile abstract concept on concept, after the manner of a philosopher, then No. But Yes, a thousand times Yes, in the sense of "do animals act thoughtfully and with judgement?" In varying degrees, of course, because as in us instinct is but a shadowy force of which we are hardly aware, so in many animals intention becomes a small power that is swamped by the great impulses of inherited modes of action.

It should be noted that modern psychological research prefers to term the lower forms of rational conduct intelligent, and reserve the word "reason" for working with general ideas or concepts. Now

It is the same with ants, as was demonstrated by Lord Avebury's experiments. Experience, not instinct, is their guide in finding their way to and from the nest, but how far their co-operation in the intricate affairs of the colony is to be attributed to instinct and how far to an understanding more or less intelligent is another matter. Difficult as it is to arrive at any understanding of the mind of mammal and bird, creatures with which we have affinity, how infinitely more difficult is it to arrive at any comprehension of the mysterious remote mind of the insect!

it is practically certain that the only mind capable of dealing with abstract ideas is the human one, hence human vanity can still tickle itself with the notion that reasoning is our prerogative, but I am convinced that in any ordinary everyday acceptance of the term animals do reason. Mind, as I have said elsewhere, permeates all life, varying in degree from the intellect of the philosopher, the mind of the little child, the intelligence of the dog, and the cunning of the raven, down to that unknown thing, the understanding of the insect; yet differing in degree and not in kind.

Chapter XXXV

Great Divers of the Bird World

By Seton Gordon

Author of "Hill Birds of Scotland"

It is early October as I write, and past me, across the headland of Rudha Hunish, in northern Skye, solans fly east in a continuous stream As they fly swiftly the keen eyes of one of their number descry a fish swimming in the sea far below There is a quick check to the powerful flight, a sudden dive followed by a plunge, and then the bird disappears in a fountain of spray beneath the surface. And amid such surroundings I begin my essay upon diving birds.

The subject is a wide one, even if its field be limited to the birds of the British Isles.

The diving birds of Britain fall naturally into three categories. First there are the sea bird divers. Amongst these are the solan or gannet, the cormorant, the shag, or green cormorant, the guillemot, the black guillemot, the razorbill, the puffin, the little auk. Secondly are the fresh-water divers. There are but few of them; for example, the dipper and the kingfisher. Thirdly are the diving birds equally at home at sea or in fresh water. The diving ducks of themselves are a goodly company in this category. Then there are the grebes, and the true divers, great northern, black-throated, and red-throated.

Each class of diving birds has its own method of submerging for its food. The solan dives from a height. If he does not drop seaward with sufficient velocity he propels himself downward with powerful wing thrusts, and then closes his wings an instant before he strikes the water. But the diving method of the solan is unique, and most of the divers dive when swimming and not when flying. The cormorant, great northern, black-throated and red-throated divers, the guillemot and razorbill, besides the diving ducks, all dive while swimming on the surface of the water. These birds use the wings immediately they submerge. Watch a guillemot or razorbill as it disappears near the bow of a steamer; you will see it using its wings to aid its descent, and they are driven just as powerfully as when used in flying.

C. J. King

GREEN CORMORANT STRETCHING ITS WING

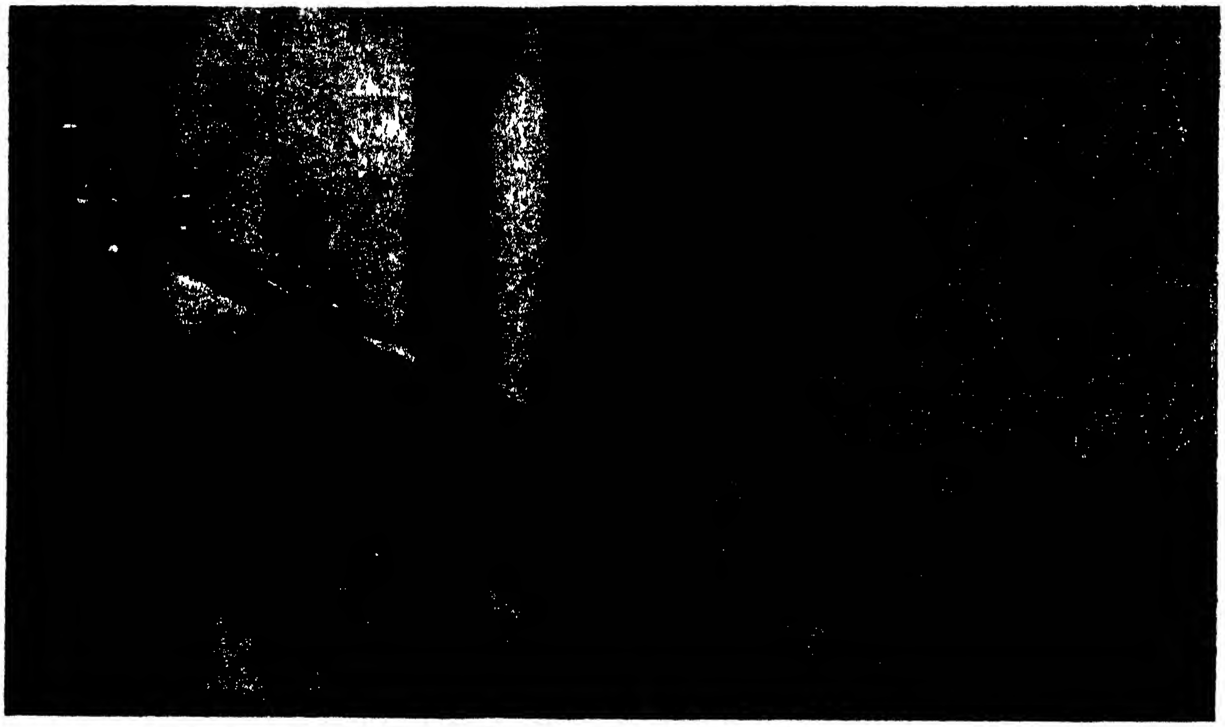
Where there are cliffs along the British coasts there will be seen the shag, or green cormorant It is easily recognized by its flight, often within a few feet of the waves. The wings beat rythmically and fairly swiftly, while the long neck is held out straight

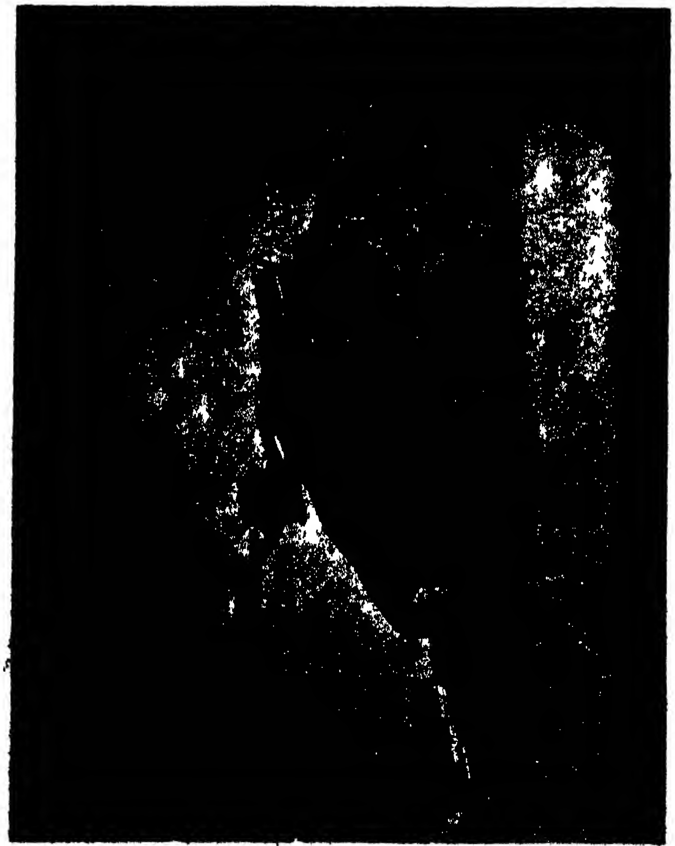
Besides the three categories of divers enumerated are birds which skim the surface of the water and may at times almost submerge themselves in pursuit of a fish. The osprey belongs to this class, as do also the tribe of the terns or sea swallows Seagulls and petrels do this also, but none of these birds is a diver in the true sense of the word. Nor can the swans, geese, and surface-feeding ducks which "stand upon their heads" when feeding be termed divers, for they do not submerge themselves entirely.

The true divers—and in this instance I refer to the great northern, black-throated and red-throated divers—remain below the water longer than any other of the British diving birds. They cruise deep on the water's surface, as a submarine might do, and when they submerge they send out scarcely a ripple. Compare their skilled methods with those of the cormorant, which half-throws itself out of the water at the commencement of its dive, and leaves a clumsy splash behind it.

Next to the true divers I would place the solan in order of skilfulness. The solan's eyesight is remarkable. It almost alone of all bird divers sights its prey in the air. The others dive first, then seek their fish beneath the wave. The kingfisher approaches the solan in method, but it dives usually from some perch overhanging a stream and not in full flight.

To the auk tribe—all of them diving birds—belong the razorbill, guillemot, little auk, and others Except during the nesting season these birds live entirely upon the waters. There is no shelter for them from the wildest storm upon North Sea or Atlantic. They must ride out the heaviest seas. Young auks leave the shelter of the parental ledge of rock before they are able to fly. Some of them are hatched upon precipices five hundred feet and more above sea level In some remarkable way they reach the water, but the actual descent has been very rarely observed. A guillemot was seen to seize its chick and to fly with it over the cliff, holding it in its bill by one





Neville Kingston

HOW THE CORMORANT FISHES

Cormorants usually dive from their swimming position in the sea, but will jump from a rock and thus gain impetus. The swimming is done with the wings, which seem to drive just as powerfully through the water as when the bird is in flight.

stumpy wing. When (as in Mingulay, one of the Outer Hebrides) some of the young guillemots and razorbills are cradled six hundred feet above the ocean, the drop must be indeed a perilous one. The numbers of downy nestlings floating dead at the cliff foot testify to the danger. It is curious that the common guillemot should take its young to sea so early, for the black guillemot, which nests beneath a boulder, with no drop beneath it and the sea, tends its young until they are fully feathered.

The divers of the sea which usually nest near one another are the guillemot, razorbill and puffin. The little auk is a winter visitor only to the seas of the British Isles. The different methods by which these three species carry their catches of fish to their families are always interesting to observe. The guillemot returns with one fish. It is usually a young herring, and is carried half swallowed, with the tip of the tail just emerging from the captor's bill. The razorbill brings back a number of fry. They are smaller than the guillemot's single fish, and are held *across* the bill. The arrangement is remarkable. They are carried in head and tail formation. Thus, if six young herrings are brought, three tails protrude alternately with three heads on either side of the captor's bill. The puffin, like the razorbill, carries its fish across its bill, but there is not the same meticulous care in their arrangement.

The young herring which the guillemot brings its chick is usually so large that the baby has difficulty in swallowing it, and the tail may

remain sticking out of its bill despite its most strenuous efforts. I have seen a young guillemot actually fall asleep thus.

Sea birds, like land birds, migrate, and the guillemot is no exception. As I write, an almost continuous stream of migrating guillemots is passing through the Minch from the north. The birds fly in companies, the low sun striking on their winter plumage so that the travellers flash white. They travel fast, for an increasing northerly wind is aiding them. They have come from afar, for our resident population of guillemots have long since left us. Perhaps they hail from Shetland, or even from Iceland, or the coasts of northern Scandinavia. None of the passing travellers halt in the Sea of the Minch. Their journey's end is unknown and is perhaps the bosom of some distant ocean far to the south.

It is curious that guillemots should be seen on migration in large numbers and yet puffins should rarely, if ever, be seen to pass. And yet puffins do migrate. I remember once being on the shore of the Atlantic not many miles from Bordeaux. The season was spring. A few days before a severe gale had passed over that part of the Atlantic, and now the shore was littered with the bodies of puffins. The birds, evidently on migration, had been overwhelmed by the force of the waves, and had perished in thousands. It seemed to me curious that a spring storm should have been so disastrous to a bird which remains constantly at sea throughout the winter, and I thought it

Neville Kingston

CORMORANT CATCHING ITS FISH

Once the cormorant has got within striking distance there is little hope for the fish on which the bird has designs. Cormorants in the sea appear to swallow their food under water, though. These wonderful action photographs were taken at the London Zoo.

King & Son

DRYING WINGS: A CORMORANT IN THE SCILLIES

All round the world from Great Britain to New Zealand, the cormorant may be found, some kinds always living by the sea and others keeping to rivers, lakes or swamps. All have dark feathers on their upper parts, giving a black appearance when seen at a distance, though actually the plumage may be dark green or dark blue with a metallic sheen upon it.

possible that the puffins might have been caught by the gale in a part of the sea where, because of strong tides, the waves were short and steep. This made me think that all birds which remain continuously at sea throughout the winter must be careful to choose ocean quarters where the seas are long and regular, and not short and steep. Especially careful, one would think, must the little auk be, for it is the smallest of the sea divers, and does not hold its head very high above the water's surface.

The little auk has its summer home far beyond the Arctic Circle. No one who has climbed to a colony of these small birds on a steep and rocky hillside of Spitsbergen can ever forget the spectacle of innumerable little auks flying in the rays of the midnight sun past him in a continuous stream, while each bird, whistling its loudest, apparently strove to drown the voices of its equally vociferous neighbours. In winter, however, the little auk is a silent bird. It is abroad upon our seas at that season of the year, yet in coastal waters is rarely observed. After some unusually severe winter storm we may read of a little auk being picked up far inland. These birds rarely recover. They are the weaklings; their stronger relatives know that land is as deadly for them as is the ocean for land birds, and avoid it at all costs.

I always associate the little auk in winter with the North Sea rather than the Atlantic. One winter day I was out at the Farne Islands. The wind was freshening, and when off the Crumstone the surf was heavy upon that lonely rock. At sea, in winter, in a small boat the waves seem more eager, and perhaps more menacing, than when watched from a larger craft, and I shall always remember seeing a little auk, a small dauntless figure, flitting above the racing breakers and seeming to embody the spirit of the storm.

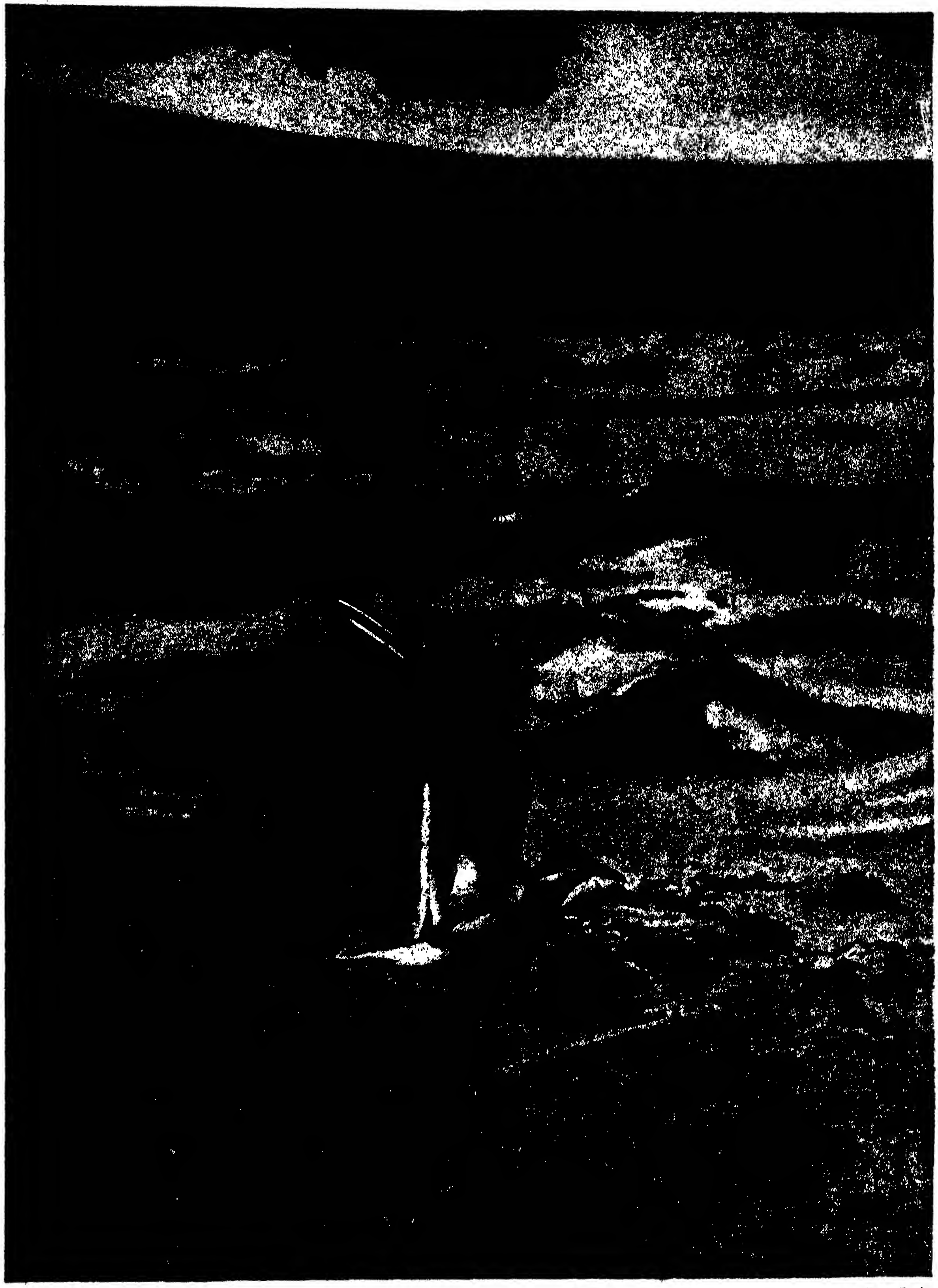
All these sea bird divers have few enemies beneath the water. A solan may meet its fate by swallowing a fish that chokes it, but I do not think that it is ever attacked by large fish. Nor are the young of guillemot, razorbill, or puffin preyed upon by sea enemies—that is, in the ordinary course of things. The solan has no enemies in the air. The puffin, guillemot, razorbill, and little auk have at least one relentless foe—the peregrine falcon. Then there are two other enemies which the puffin has to contend with, at its nesting place, and these are the greater black-backed gull and the raven. Both these birds regard the puffin as fair game. A greater black-backed gull will take up its position beside the burrow where a puffin is tending its downy young. It may hear the puffin moving within. At all events, it stands there, quietly and expectantly, and at last, if fortune favours it, out comes the unsuspecting puffin, when it is seized by the powerful gull, disembowelled, and often left to die in misery.

The raven is not so frequently seen to prey upon nesting puffins, but one family of ravens were known to hunt these unfortunate birds systematically, standing together beside a burrow, and expectantly watching for the appearance of the victim, which

W S Berridge

"ALLAN O' THE SOUTH WIND"

In the west of Scotland the fishermen say that when they hear this bird, the great northern diver, calling, a storm will come up with the south wind bringing mist and rain-squalls. They call it "Allan o' the South Wind" The bird is nearly a yard long.



Seton Gordon

ARCTIC TERN RISING FROM ITS EGGS UPON THE SAND

When fishing, the Arctic tern comes down upon the water with such force that it is sometimes completely hidden for a moment by the spray, and is almost, if not entirely, submerged in the act of taking its fish. The bird breeds in Britain, as far south as the Farne Islands on the east and in the Scilly Isles on the west. The eggs are laid in a depression in the sand that can hardly be called a nest, and it is as well not to approach too near, for the Arctic terns have a habit of banding together to mob an intruder.

Neville Kingston

PENGUIN DIVING FOR ITS PREY AT HIGH SPEED

Penguins are the champion under-water swimmers of the bird world. Their speed beneath the surface is extraordinary, and is due to the fact that their wings are specially made as paddles and do not have to serve the birds for flight as well. They feed on small crustaceans and fish, and are capable of staying submerged for a considerable time.

they promptly despatched. But all this is on land, and it is really surprising how few enemies bird divers of the sea have.

Now let us study for a time birds that are equally at home at sea or in fresh water—birds which feed on the fish of the sea, and the fish of lakes and rivers.

The most interesting of these feathered fishermen are the great northern diver, the black-throated diver, and the red-throated diver. They are all magnificent divers and swimmers. Their bodies are slim, their feathers are tightly pressed to the skin, their legs are set far back; they are very oily. Their young can dive when an hour out of the egg, and not only can they dive but they are able to remain submerged and swim beneath the surface even at that tender age.

The great northern diver is the largest of the three. It is a magnificent bird, powerful and shapely, and in summer plumage it is most handsome. It is able to remain submerged longer than any other diver. When fishing in deep water a great northern diver submerges on an average for a minute and a half, and during that time may travel beneath the water for several hundred yards. When it appears on the surface it is holding (if its fishing has been successful) a fish in its powerful bill for, unlike the solan, it does not swallow its prey beneath the surface. If the fish be a fair-sized flounder the diver may have considerable difficulty in disposing of it. This habit of the diver in swallowing its catch on the surface is unusual. The cormorant and the shag, as often as not, seem to dispose of their fish in the depths of the sea, although if diving for sea trout in a shallow river estuary a cormorant swallows on the surface.

Seton Gordon

RED-THROATED DIVER ON ITS NEST AND A MUSTER OF PUFFINS

All the true divers, great northern, red-throated, and black-throated, swim deep in the water and dive with the least possible disturbance, remaining below the surface longer than any other British bird. The red-throated diver is the smallest of its family. In the autumn the red tint is lost for a time. The bird usually breeds by the banks of a tarn and the eggs are often laid right at the water's edge. Puffins (top) are very good divers and swimmers and nest in rock clefts.

James

GANNET, OR SOLAN GOOSE

Most spectacular of the divers is the gannet or solan goose which, while flying, will suddenly close its wings and drop like a stone into the sea with a great splash. The food is chiefly herrings and pilchards. A gannet is often nearly three feet long.

The great northern diver is known to the Gaelic-speaking fishermen of the West as Allan of the South Wind, for when the diver calls they know that within a few hours the wind will back to the south, and bring with it stormy weather with mist and driving rain.

The red-throated diver is the smallest of the three divers. The great northern diver nests no nearer to us than Iceland; the red-throated diver nests in Scotland, but is so widely distributed that it is found in the Arctic, in Spitsbergen, North East Land, Franz Josef Land, and indeed in the far north wherever the foot of man has trod. This diver usually makes its nest beside a very small lochan or tarn hidden away on the moors, and does all its fishing in the sea.

The black-throated diver—a scarcer bird in Scotland than the red-throated species—on the other hand, fishes on its nesting loch; but it always chooses as its nesting loch a sheet of water large enough to hold fish in abundance. There is one pair of black-throated divers of my acquaintance, which nest upon an island where they have as neighbours a colony of herring gulls. One day, when rowing near the divers' island, I saw the divers cruising with their small family far out on the loch. On seeing the boat the old birds submerged and one of the young swam toward the shore. The other continued to float on the water, and was seen by a hungry gull. The gull swooped down, and though I shouted at the top of my voice, continued on its sinister course and was within a foot of the young diver when I succeeded in exciting our collie dog, Dileas, to such an extent that she barked with terrific vigour. That *did* scare the gull, but had the collie barked two seconds later the chick would have served as a tasty tit-bit and its career would have come to an abrupt close.

The great family of diving ducks are, most of them, equally at home upon the sea or on fresh water. Some of them are sea birds in winter and land birds in summer. The long-tailed duck, for example, is a bird of the inland lakes in Iceland (where it nests), but when it leaves Iceland for the coasts of Britain, where it spends the winter months, it desists from its fresh-water habit and is entirely a bird of the salt water from October until April.

Like the long-tailed duck the scaup is a bird of salt water in winter and a bird of fresh water in summer. The eider duck, on the other hand, is a salt-water bird summer and winter, and for this reason is not easy to tame and keep on a lake. There was an old eider drake in Viscount Grey's bird sanctuary at Falloden, and the old fellow was very tame. He spent most of his time courting wild duck. The drakes did not mind his attentions to their mates, for they evidently regarded him as harmless

The dipper or water ousel is not a diver in the true sense of the term, yet it is equally at home on land or beneath the water. Except in unusually severe weather the dipper avoids salt water; its home is on quick-flowing rivers and hill streams, and I have seen it at the Wells of Dee, just four thousand feet above the sea. The dipper can do what no other bird can do, namely, walk about on the floor of a river pool with several feet of water flowing above it. Walking thus on the bed of the stream it searches amongst the stones for its food, which consists chiefly of aquatic larvae.

The dipper, I suppose, is the only diving bird of Britain which has a song in the true sense of the word. Not only in spring does the water ousel sing. In the depths of winter, standing on some stone in mid-stream, it pours out a flood of sweet music, soft and uninterrupted, as the December light fails.

The dipper is a very early nester. On Lower Deeside, in Aberdeenshire, I have seen its completed nest on the opening day of the salmon fishing (February 11). One of the dippers which my wife watched from a "hide" was an unusually cheery fellow. He (for one presumes it to have been the male) was always singing, although he had a hungry family to feed. One day, after he had fed his brood, he thrust his head well inside the domed nest on a boulder in mid-stream, and poured out a flood of song. Perhaps he was giving the family a singing lesson! The young dippers must have been deafened by a torrent of sound that made their mossy home ring; they may, I imagine, have felt rather like the English visitor to a certain noble castle in the highlands when not one piper, but seven, marched together into the dining-hall after dinner and, piping shrilly, three times circled the room!

Neville Kingston

SWIFT-DIVING CORMORANT HUNTS ITS PREY BENEATH THE SEA

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Chapter XXXVI

Strange Animal Friendships

By Lewis Spence

Author of "An Introduction to Mythology"

STRANGE comradeships between animals, sometimes of the most dissimilar species, seem to show that there are exceptions to the maxim that hostility is the law of nature. Queer compacts are frequently made between domestic animals, and this leads to the assumption that those species which have been "adopted" by man become in a measure "civilized," and relinquish a part of their savage instincts. Be this as it may, affinities between various species were almost proverbial in the ancient world. For example, the strong partiality of the horse for the goat as a stable-companion is alluded to by more than one medieval writer. Herodotus mentions the association between the crocodile and the Egyptian plover, a fact long scoffed at as an absurdity by naturalists, and the fables of Aesop are eloquent of dealings between beasts, some of which may have been founded on direct observation, although, it need scarcely be said, they are for the most part matter of pure allegory.

But every apparent friendship between birds and beasts must not be attributed to mere good-natured tolerance or any excess of amiability, for the lying down of the lion with the lamb is an occurrence quite as uncommon as the hobnobbing of Turk with Armenian. The Montagues and Capulets of Nature do not so readily abandon their vendettas. It is scarcely in a spirit of playful amusement that the crocodile fraternises with the plover. His motives, indeed, are those basely selfish ones which inspire the human to be a trifle obsequious to his dentist, for it is in that capacity that *Pluvianus aegyptius* acts toward his rapacious client. To the gums of the crocodile adhere colonies of ravenous leeches, which cause him considerable discomfort, and these the plover deftly removes with its bill. The arrangement is therefore one of mutual advantage, and this, indeed, is symptomatic of many another apparent intimacy between species the most incongruous.

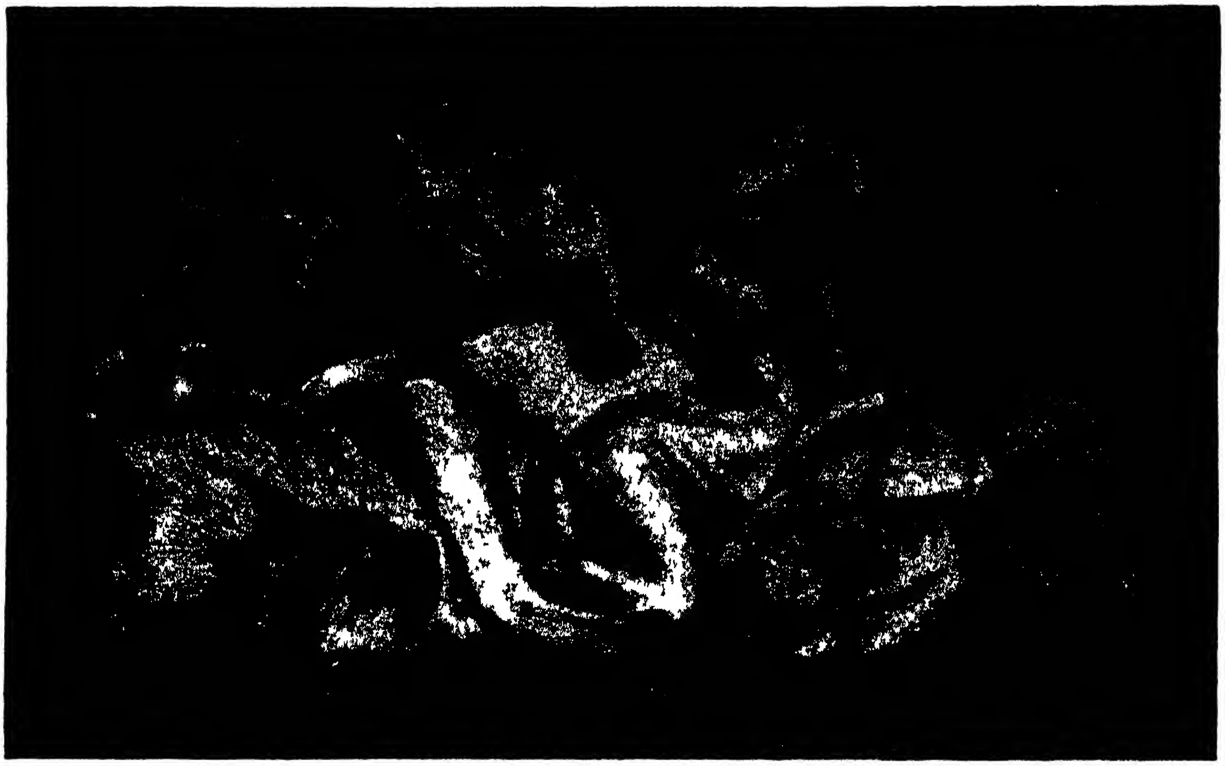
These convenient alliances have numerous parallels in marine and insect life, as the sequel will show. But more genuine friendships between creatures of widely different species are scarcely to be accounted for otherwise than by "personal" affinity. Such a partnership was that chronicled by the late C. J. Cornish between a donkey, a mare with a couple of foals, and a mastiff, in pastoral Derbyshire. The donkey had learned to open gates, an accomplishment, it seems, not unusual among his tribe, and thus managed to reach his equine friends. Later they were joined by the great house-dog, and, like the animals in Grimms' folktale, all set forth on their adventures, wandering over the countryside until they encountered human interference in the shape of a farm labourer, who drove the horses back to pasture. The donkey, abandoned by his comrades, returned home, still accompanied by the mastiff, which, perhaps, had been inspired by the natural motive of his race to safeguard his master's property.

But friendships much more singular have been recorded. Years ago in the Zoological Gardens at Antwerp a wretched little stray dog was thrust into the cage of a lion to serve his majesty as light refreshment. But to the surprise of the keepers, Leo, after sniffing at his destined prey, began to lick him over in the most affectionate manner. Far from being frightened, the dog made every demonstration of satisfaction, and shortly the pair became inseparable, the lion refusing to allow his new acquaintance to be removed from the den. For hours the dog would lie curled up between the lion's paws; it shared his food, and when efforts were made to remove it, set up a doleful yelping, to the accompaniment of the wrathful roarings of its protector.

A case is recorded in which an Australian opossum and a setter became inseparable, lying asleep together on the hearthrug during the day, and playing with one another in the evening. The dog submitted to the opossum washing his face, though it was plain that he resented the operation.

I REMEMBER an inseparable comradeship between a parrot and a fox-terrier, the pets of a relative. The parrot had practically the run of the house, and would flutter up and down stairs, accompanied by the terrier, uttering discordant cries and occasionally questionable language if the dog disappeared for a moment. To watch them wrestling for a walnut, the parrot inserting his beak between the terrier's jaws, was a standing amusement. But the most incongruous instance of animal friendship within my recollection is one between a monkey and a billy-goat. The monkey, the property of a neighbour, had on one occasion been tied, despite its struggles, to the goat's back, to play the part of Mazeppa in "The Wild Horse of Tartary" as part of a childish game. In that prone position it naturally showed every sign of acute annoyance and discomfort, but when placed on the shoulders of the animal in the attitude of a jockey, it not only appreciated the exercise which the truly terrified goat certainly gave it, but when removed, insisted on returning to its seat, frequently visiting the garden, and mounting the goat of its own accord. By degrees its victim grew accustomed to the sport, and tolerated his rider, although a nanny-goat refused the privilege and tossed the monkey badly more than once when it boldly attempted to mount her.

Cornish records a most extraordinary case of friendship between a goose and a crane, both of which belonged to the late Lord Lilford's collection of wildfowl at Lilford Hall, near Oundle. The



BULL TERRIER AND A FAMILY OF KITTENS

Provided that they get to know each other at a sufficiently early age dogs and cats will usually live together in peace. This bull terrier pup appointed itself guardian of a litter of Siamese kittens, and provided his comparatively ample body as a kind of warm couch against which the kittens could lie and be comfortable. The benefit was mutual for the fur coats of the kittens helped to warm the dog. Cats and dogs are proverbial enemies but, nevertheless, friendships such as this often occur, if begun early enough, and continue unbroken.

goose, which was of an Australian species, practically annexed the crane altogether, feeding beside it, and never venturing more than a few yards from it, or allowing it to be out of its sight for a moment. If another crane or a visitor approached it, the goose rushed at the intruder and made as if to bite. For some six months the crane was removed, and when it was returned to the enclosure, the goose at once made every demonstration of joy.

Indeed the goose seems peculiarly prone to friendship. J. C. Hauzeau speaks of a Chinese goose which conceived a quite violent affection for a dog, and which hissed vindictively at any person or animal who offered to interfere with its favourite. When at last its friend was killed by another dog, it pursued the murderer for a long distance, and appeared grief-stricken for days after, moping in a corner of the farmyard, refusing food and all companionship from the rest of its species.

An exceptionally curious instance of animal friendship is that between a cat and a frog, described by W. H. G. Kingston. The servants of a country house had enticed a frog from its hole by giving it food. As winter came on, the frog grew quite tame and was in the habit of making its way to the kitchen fire for the sake of warmth. The usual occupant of the hearth was a favourite old cat, which from the first showed no animosity towards the newcomer. In course of time the frog gained confidence, and actually nestled beneath the cosy fur of puss, which seemed perfectly content with the arrangement. Every evening the frog hopped forth from its hole and nestled like a kitten beneath the soft coat of the cat, which constituted herself its protector, and would not allow it to be disturbed.

"A spaniel," says the Rev. James Wood, "shared his food with an unpopular cock which had been ostracised by the other poultry in a certain farmyard." The bird was not allowed to have a share of what was going, but was driven off and severely maltreated. But the dog became his champion, and stood on guard while he ate a portion of the general meal. At times the bird had even to be fed in the dog's kennel, so bitter was the animosity of the other fowls against him. In the end, however, the cock was found dead in the kennel, as the result of the bad treatment he had received. When discovered, he was "lying closely pressed to his only friend."

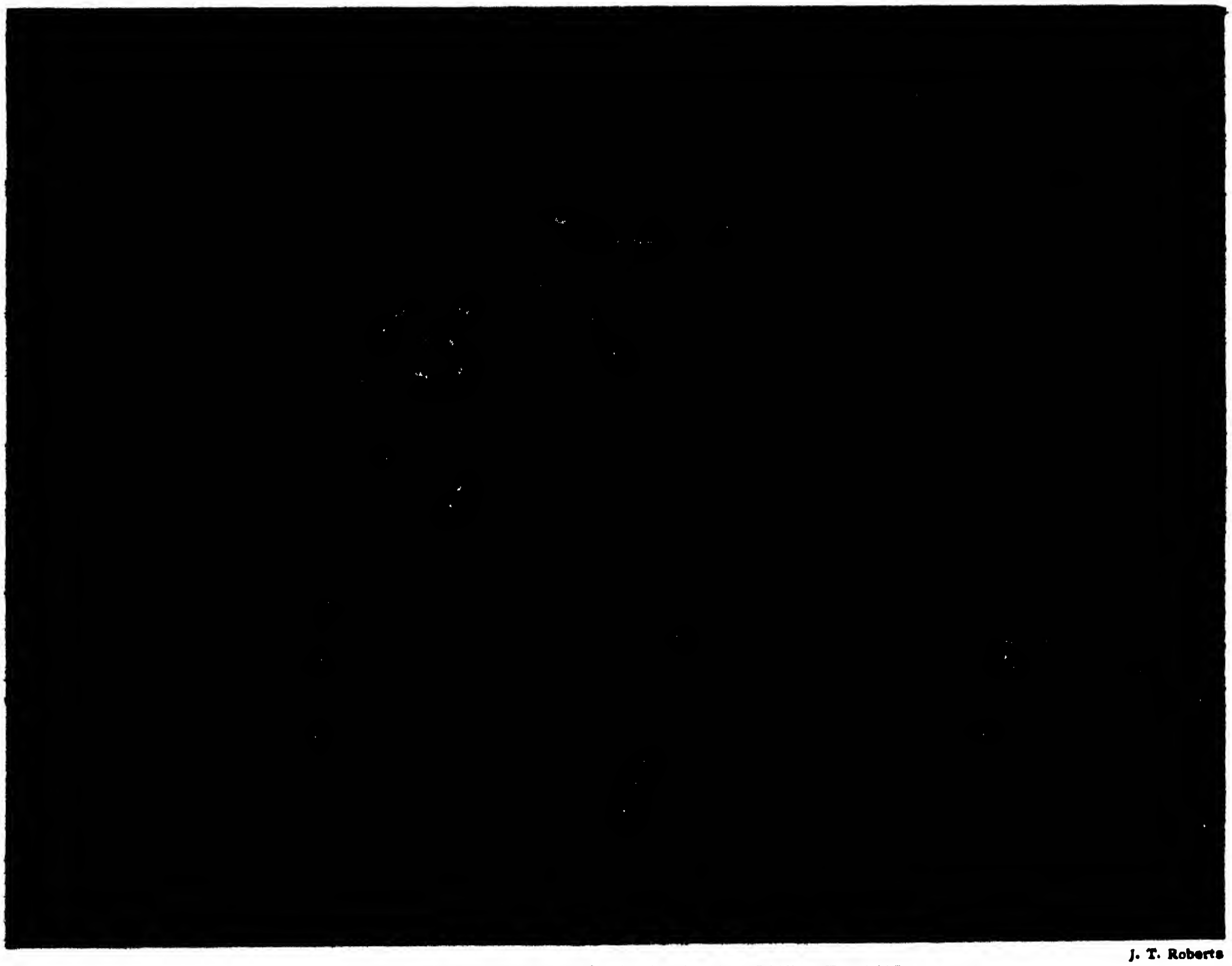
Dr. Lauder Lindsay quotes "a local paper of high standing" as vouching for the extraordinary case of a hen hatching out her chickens in a watch-dog's kennel. "The two seemed to understand each other so well that, on her leaving and entering the kennel the dog rises and makes way. . . . Any attempt to abstract the eggs in the absence of the hen meets with the immediate disapprobation of the dog." He also mentions the case of a tame rook, which was

very fond of two dogs, one being a bulldog. The rook constantly rode on their backs, and accompanied them on their journeys abroad.

A case is on record of a kitten, born on the roof of an outhouse, which was, by accident, deprived of its mother and brethren. It evaded all attempts to catch it, but just below where it lived a brood of chickens were constantly running about. Growing weary of solitude, the kitten scrambled down and joined the feathered band, which showed no fear of it. In a short time a perfect understanding was established between the kitten and his friends. He assumed the part of leader, and used to conduct them about the grounds, occasionally hiding and darting at them from ambush. One pullet was his especial favourite, and when other broods appeared, the kitten, now grown into a cat, transferred its interest to them, the hen appearing in no way alarmed at having so unusual a nurse for her offspring. A similar instance of comradeship between a cat and a pigeon, whose young had been destroyed by rats, is noticed by Kingston. Feeling instinctively that she would be in safer quarters near puss, the bird sidled up to her, and the pair became inseparable, feeding out of the same dish, and the pigeon brooding over the kittens in the absence of their mother.

Dr. Lauder Lindsay recounts a story of a mastiff and a cat, which, as puppy and kitten, had shown so strong a liking for each other that at last puss took up her quarters in the watch-dog's kennel. She never seemed happy when away from him. She ate her breakfast out of the dog's bowl, and slept in his kennel, with his paws around her. She used to catch mice and young rats and bring them to him, seeming quite pleased when he accepted friendship's offering. When she produced a litter of kittens, the mastiff acted as nurse to them in her absence, and her only surviving offspring in time became as fond of the dog as her mother had been.

The late Rev. J. Watson tells of a strange friendship between a tame tiger kept on board ship on a voyage home from India for a dog, to which it "took" at first sight. The dog, on his part, was not quite so



J. T. Roberts

WELSH COLLIE AND HIS BROWN OWL FRIEND

By some strange process in its mind, this brown owl conceived a liking for the company of a four-footed creature, with which it could not, in the ordinary way, possibly have anything in common. The bird was of the air, and the dog of the ground, and why should the inhabitants of either take any interest in each other, save from the point of view of either eating or being eaten. Yet, unaccountable as it seems, here are the two strangely assorted friends as they were constantly seen together.

Keystone

E.N.A.

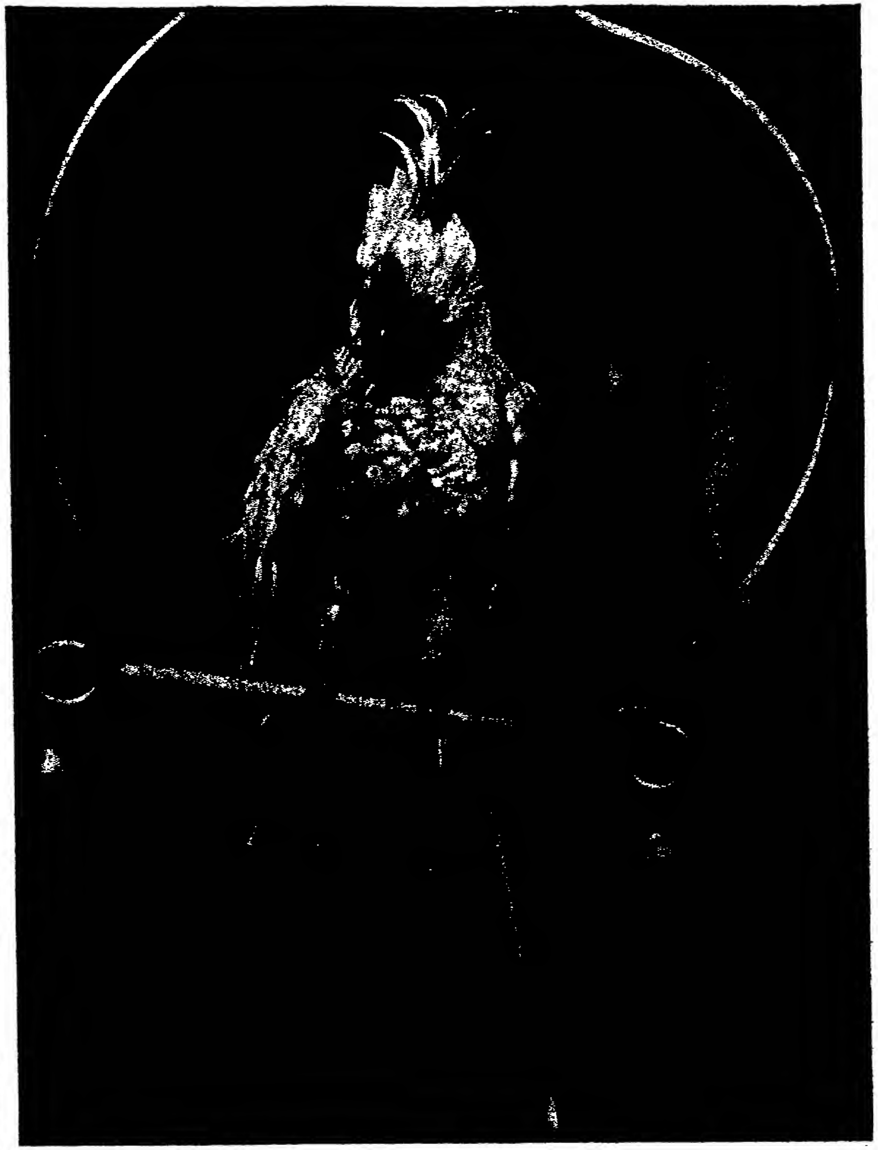
CAT WHOSE MOTHER INSTINCT WAS STRONGER THAN THE DESIRE TO KILL

While all the members of the cat family from tiger to domestic tabby are renowned for ferocity, it cannot be denied that cats are excellent mothers. When this strong maternal instinct is thwarted strange things may happen, as we see here. A family of chickens (bottom) and, even more astonishing, young rats (top) may not come amiss to the cat if her kittens have been taken away from her. In the case of the cat in the upper photograph the young rats were actually offered to her, originally, as something to eat.

Neville Kingston

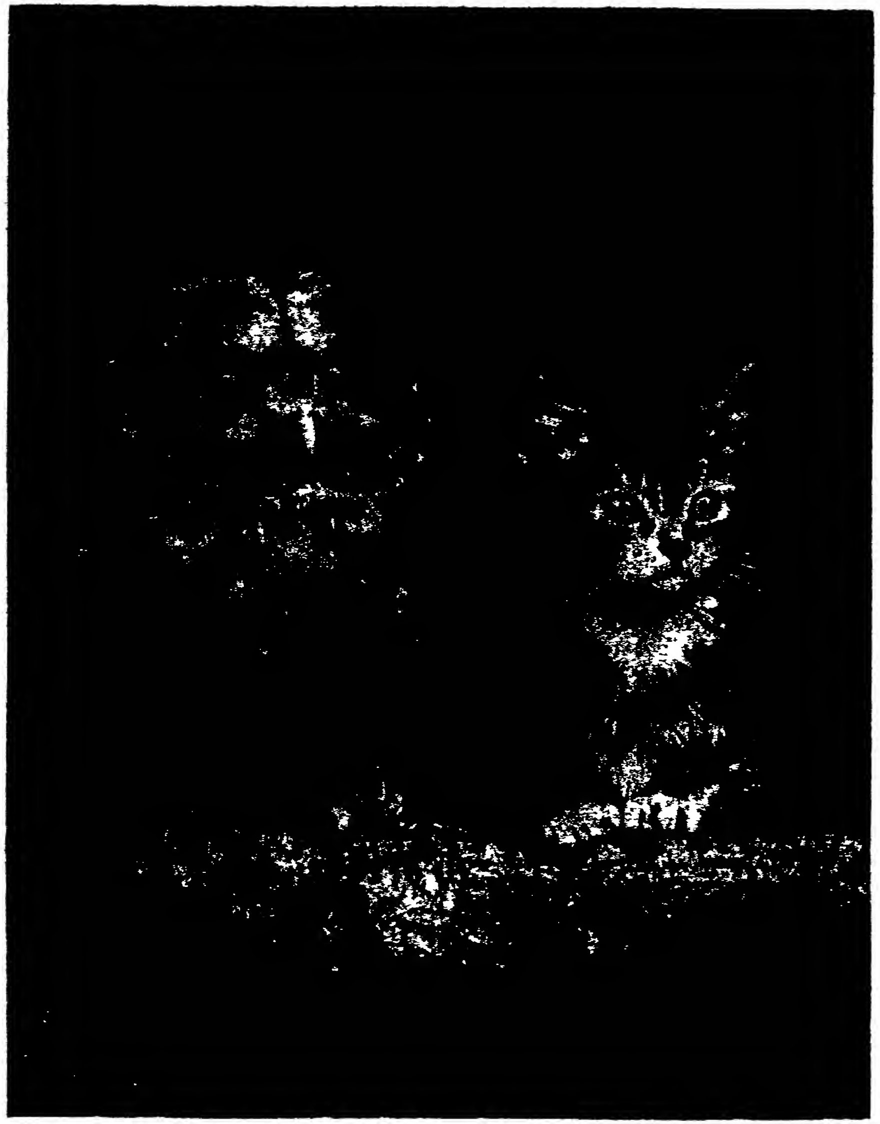
QUEER ZOO FRIENDSHIP AND UNUSUALLY MIXED BATHING

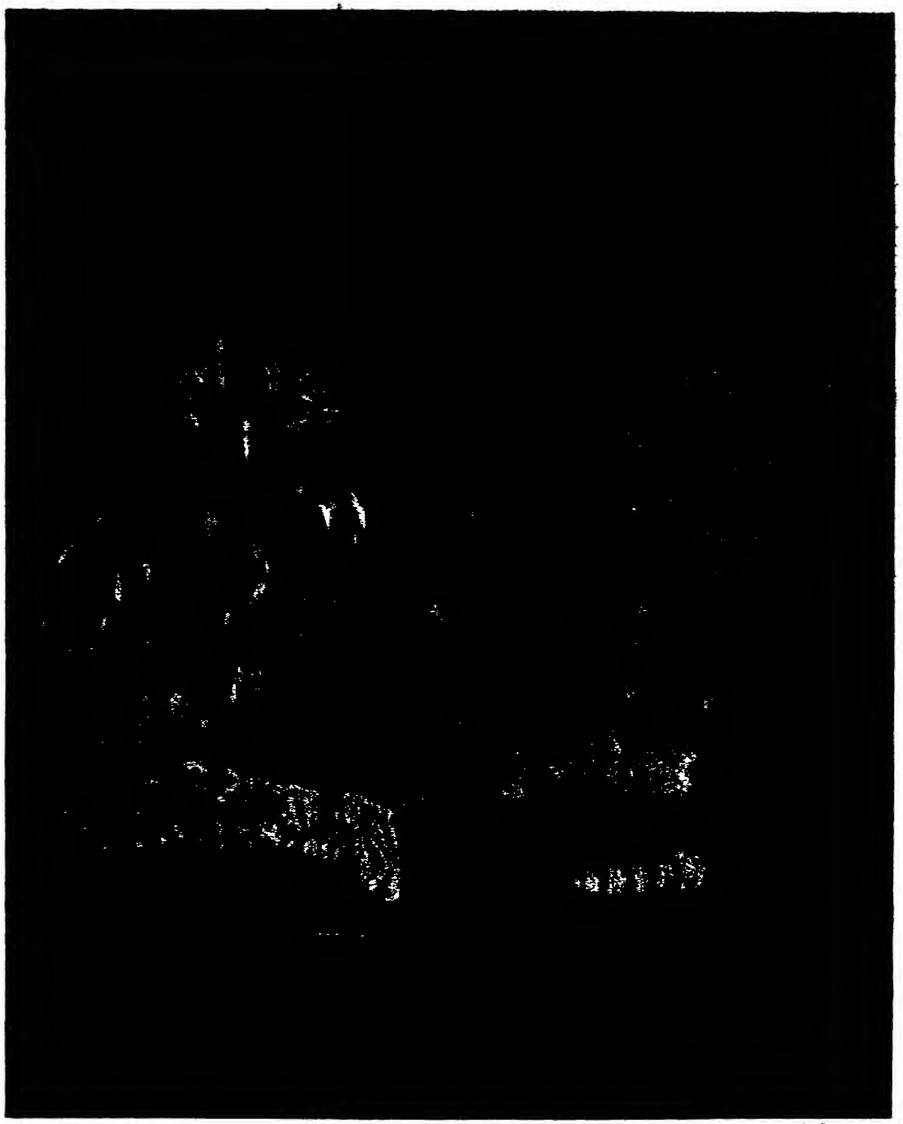
It seems surprising that while animals will very often turn upon a stranger of their own kind, yet they will make friends with a member of an entirely different race. One of the strange friendships formed at the London Zoo was that of an orang utan and a tree kangaroo (bottom). In the upper photograph we have a scene on the Serpentine in Hyde Park, where two pets, a monkey and a dog, are enjoying themselves together in the water. The monkey, it will be noticed, is on all fours like the dog.



BIRD AND BEAST LIVING TOGETHER IN CLOSE AND HAPPY COMPANIONSHIP

In a certain private collection of animals there used to be a monkey who was attracted by a cockatoo (right) and, braving the beak and claws of this bird, which can be fierce enough when it likes, was happy to find his friendship returned. The two would sit on the bird's swinging perch for hours, contentedly rocking to and fro, the monkey's extra weight being handy in keeping the swing moving. The cat and the starling in the left-hand photograph came together in this way. The cat was owned by a miner who one day found a young starling which had broken its leg. He put the leg in splints until it was well when, although allowed full liberty, the bird preferred to stay, taking its meals with the cat.

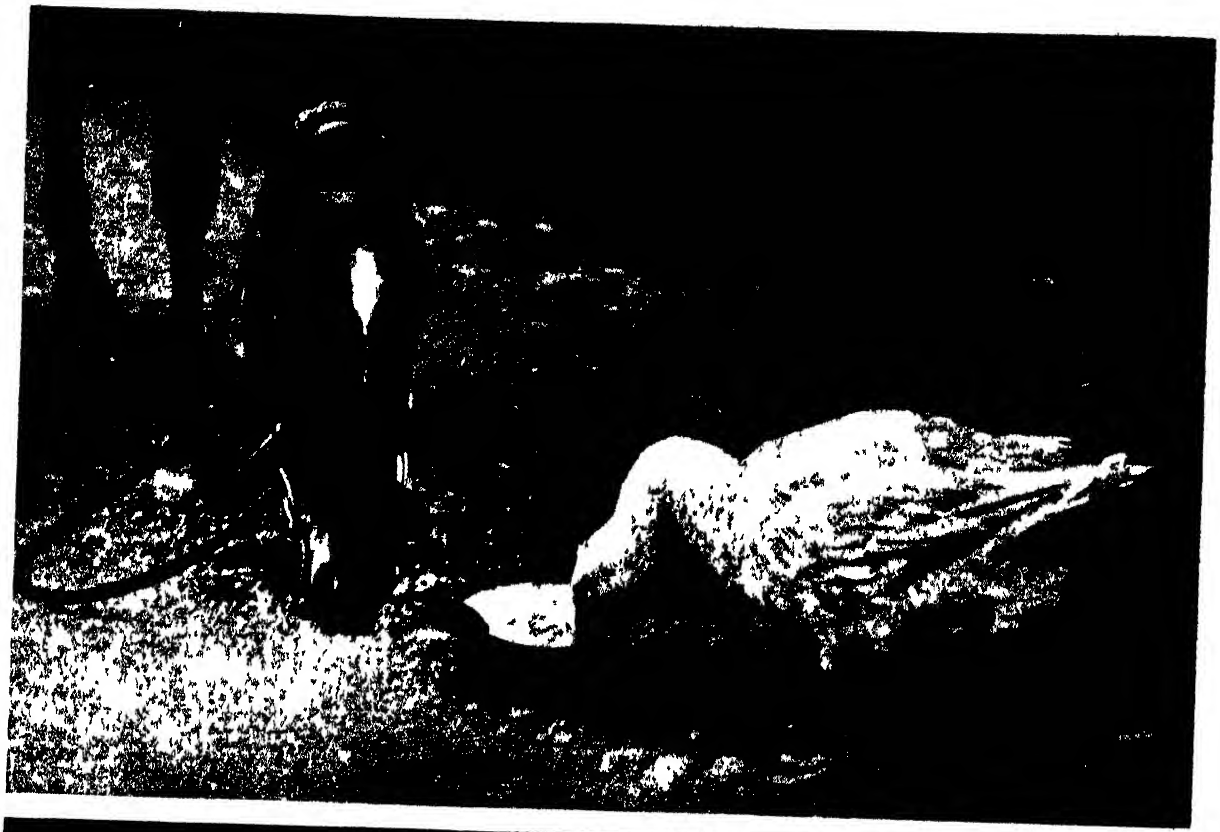




J. T. Roberts

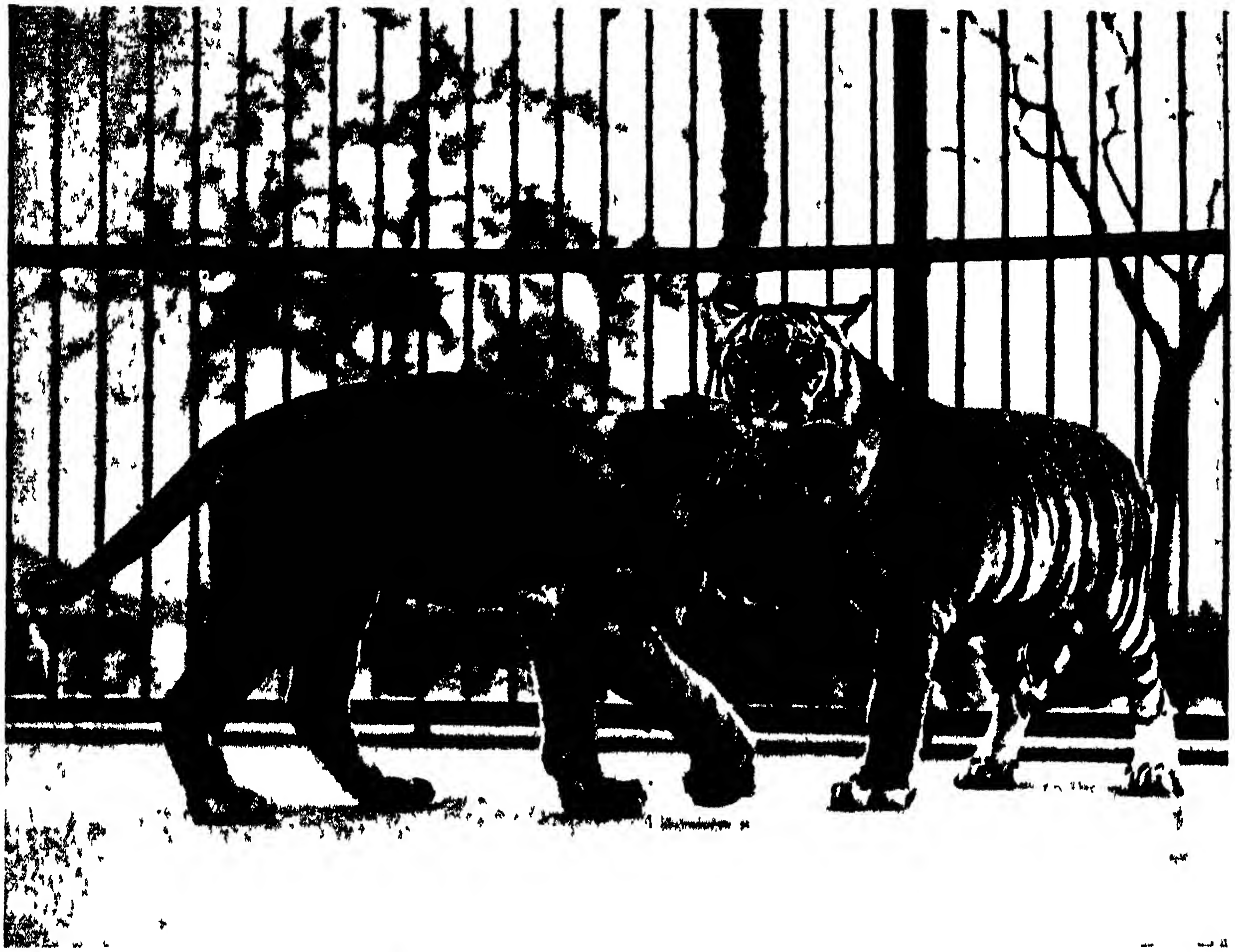
OWL AND CAT THAT MET IN THEIR YOUTH AND GREW UP TOGETHER

When the influence of man interferes with the normal circumstances of an animal's life, abnormality in some form is often the result. The cat and the owl are both carnivorous creatures which live by hunting and killing, if hungry enough, any living creature sufficiently small to be successfully attacked. But in this case, a young owl which was introduced to a kitten under human influence, settled down contentedly and grew up side by side with it. At first the bird was larger than the kitten (left) but at the end of twelve months the kitten had become a cat and far outgrown its friend in size. But twelve months of friendship, which the camera has recorded, succeeded in keeping the peace even when the cat was big enough to make itself dangerous.



PIGEON AND GOOSE WITH THE COMPANIONS OF THEIR CHOICE

Rats will steal pigeons' eggs if they get the chance, and the pigeons recognize their mutual enemies quickly enough. But years of inherited enmity did not prevent this pigeon (bottom) submitting to play the part of horse for a young rat to ride. Geese appear to be very prone to make friendships with other animals, and one particular bird (top), which was kept as a mascot in a polo stable, took a fancy to one of the ponies. The two would accompany each other to the fields and feed together in silent but faithful friendship.



Nevill e Kingston

TIGER AND LION LIVING TOGETHER AT THE ZOO

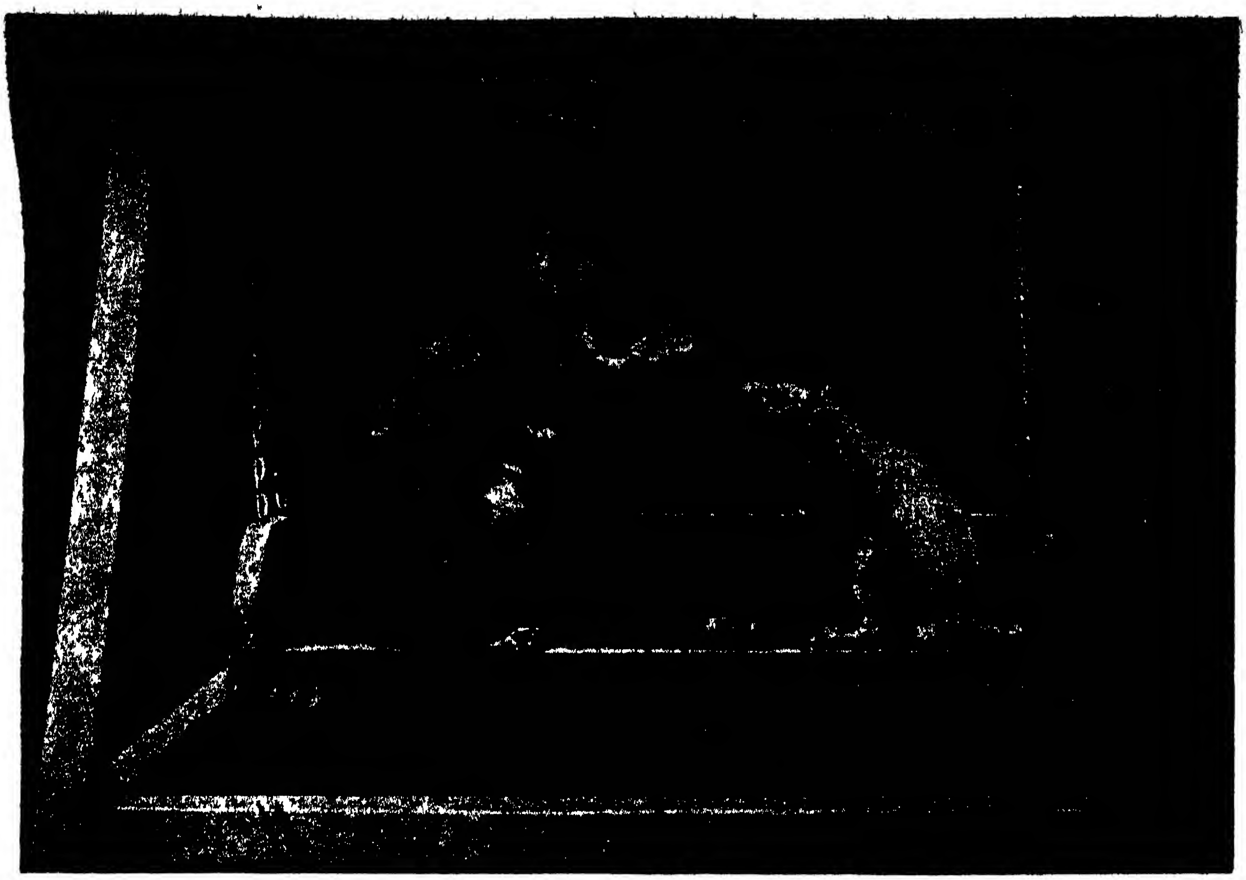
Perhaps mutual tolerance would be nearer the truth than friendship as a term to describe the relationship between the tiger and the lion which were put in the same cage at the Zoological Gardens, London. Luck seems to play a great part in such associations between the large carnivora. So small a matter as a wasp sting on the nose might lead to the victim snapping at its companion purely as the result of the shock. Then, if the fight was not stopped in time the lion would probably be vanquished by the more rapidly moving tiger.

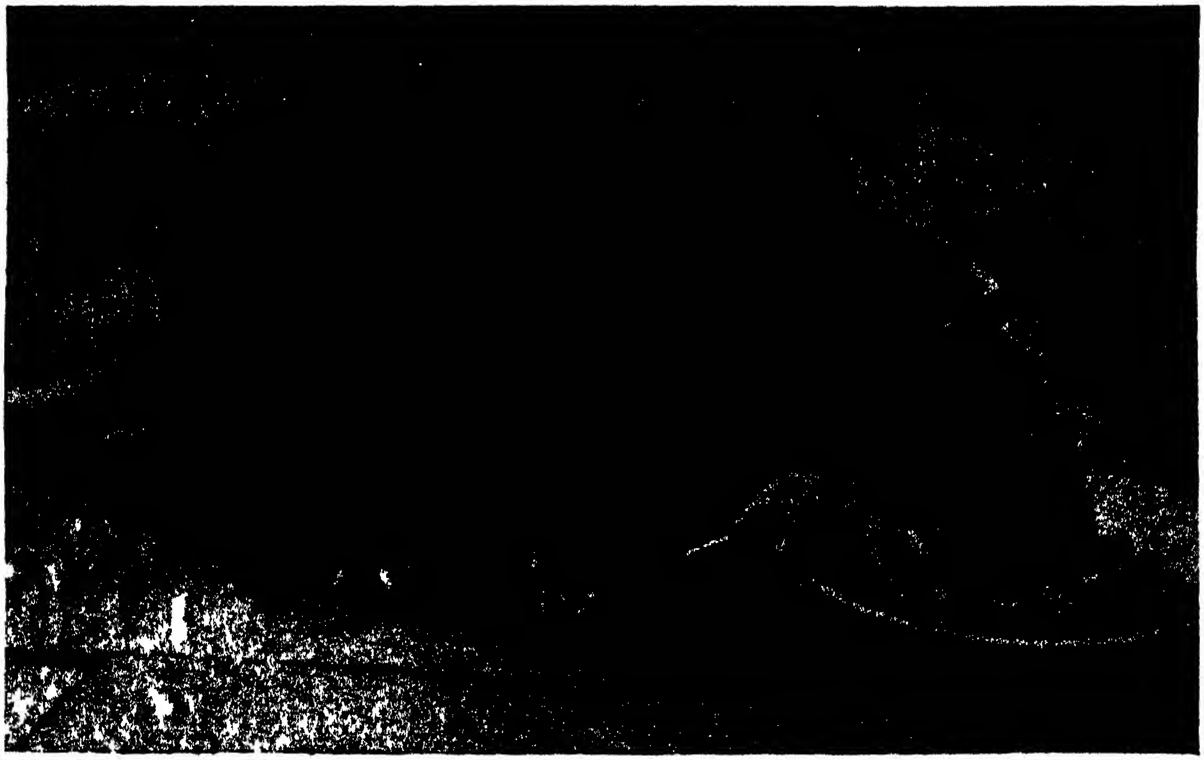
anxious to strike up an acquaintanceship, but after a day or two of comradely advances on the part of the tiger, it displayed not the slightest fear of its new messmate, and the twain henceforth became inseparable. Thomas Belt tells of the singular attachment of a young jaguar for the dog which had captured it. It became greatly attached to the dog, living with it in harmony as a companion.

INSTANCES of animal friendship arising through compassion are not rare. A terrier dog was suffering so severely from distemper that it was necessary to confine her to her kennel. A bantam cock, noticing her plight, took pity on the sufferer and squeezing himself through the bars of the kennel, took up his abode along with the stricken terrier, never leaving her save to pick up his daily food. When he did so, the terrier whined and betrayed every symptom of uneasiness. Her condition became worse, and the bantam, for the purpose of keeping her warm, took his place between her forelegs, the poor little invalid making use of her feathered friend as a sort of hot water bottle. Eventually the terrier succumbed to the disease, when the bantam appeared inconsolable at the loss of his friend, and it was some time before he recovered his usual spirits.

Sir Benjamin Brodie remarks that the want of society is specially felt in the case of domestic or gregarious animals which are accustomed to be constantly surrounded by friends and companions. In their case, solitary confinement is frequently attended by dementia or other forms of mental derangement, just as in man. Mr Frank Buckland, once editor of "Land and Water," says that horses dislike solitude, and are rendered savage by being kept alone. Love of company is, indeed, strongly marked in the horse. Pierquin cites a case of frenzy in a carriage horse when his companion was not in harness with him. White and Stirling have shown that the pigmy ape and other animals exhibit mental disturbance when deprived of companionship.

Every now and again in the daily Press odd cases of animal fosterage are alluded to. We read of a hen mothering a brood of ducks or a cat rearing puppies

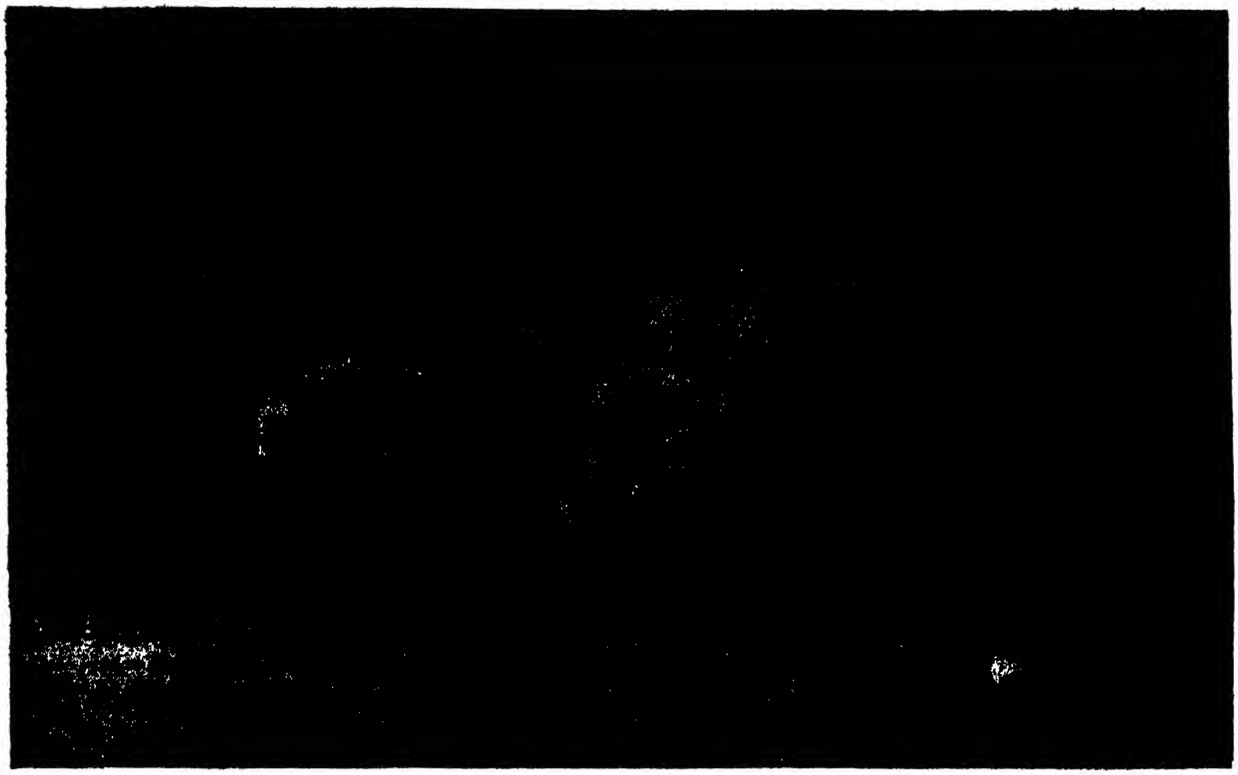




Neville Kingston

RAT FRIENDSHIPS FOR OTHER ANIMALS

A seemingly unfair competition is illustrated in the lower photograph, where a Gambian giant rat is feeding out of the same bowl as a white mouse. The rat is one of two African species possessing cheek pouches, and it attains a length of two feet. A rat the size of a terrier is an unusual pet, and certainly a rather dangerous companion for the diminutive white mouse. The upper photograph shows a tame squirrel which became friendly with a rat with which it shared its meals.

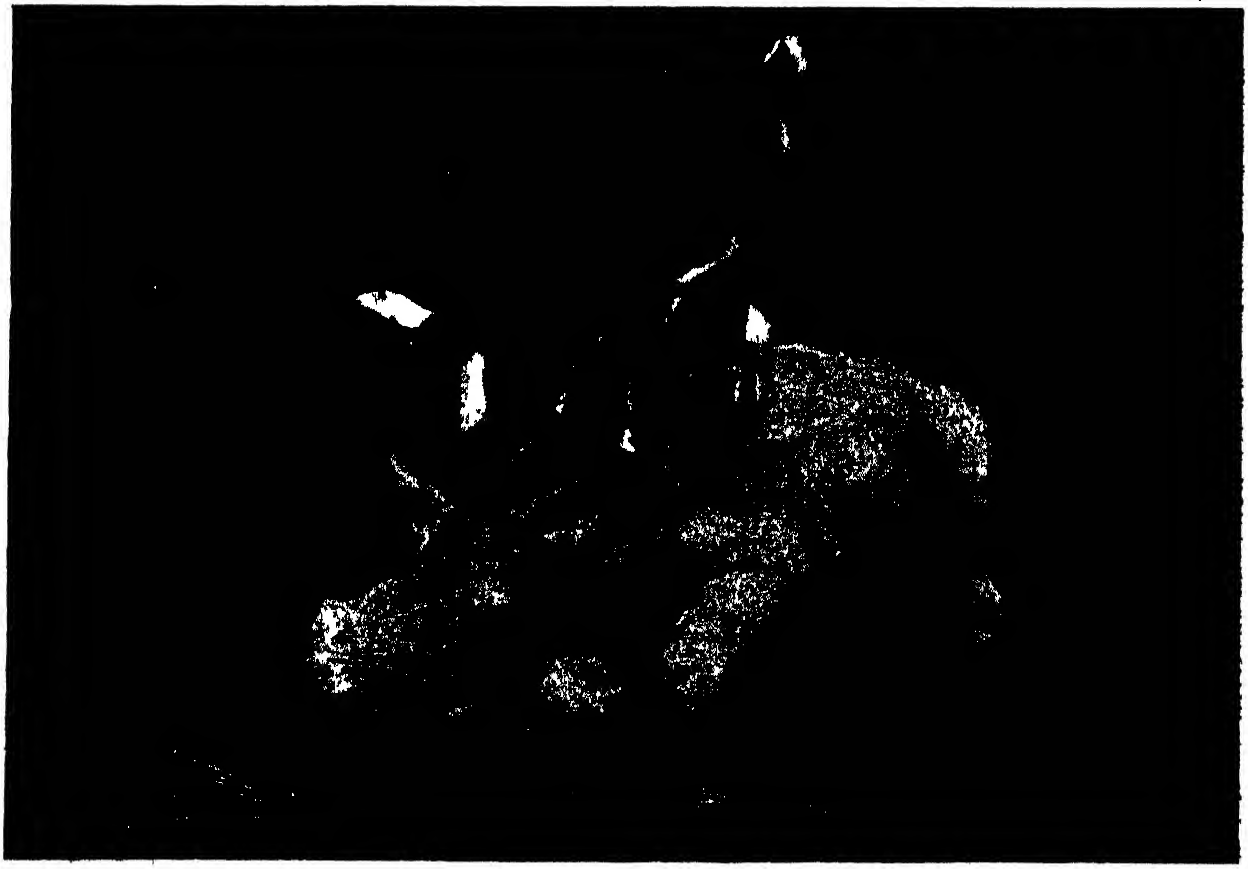


Neville Kingston

GREAT CARNIVORA IN TOLERANT MOODS AT THE ZOO

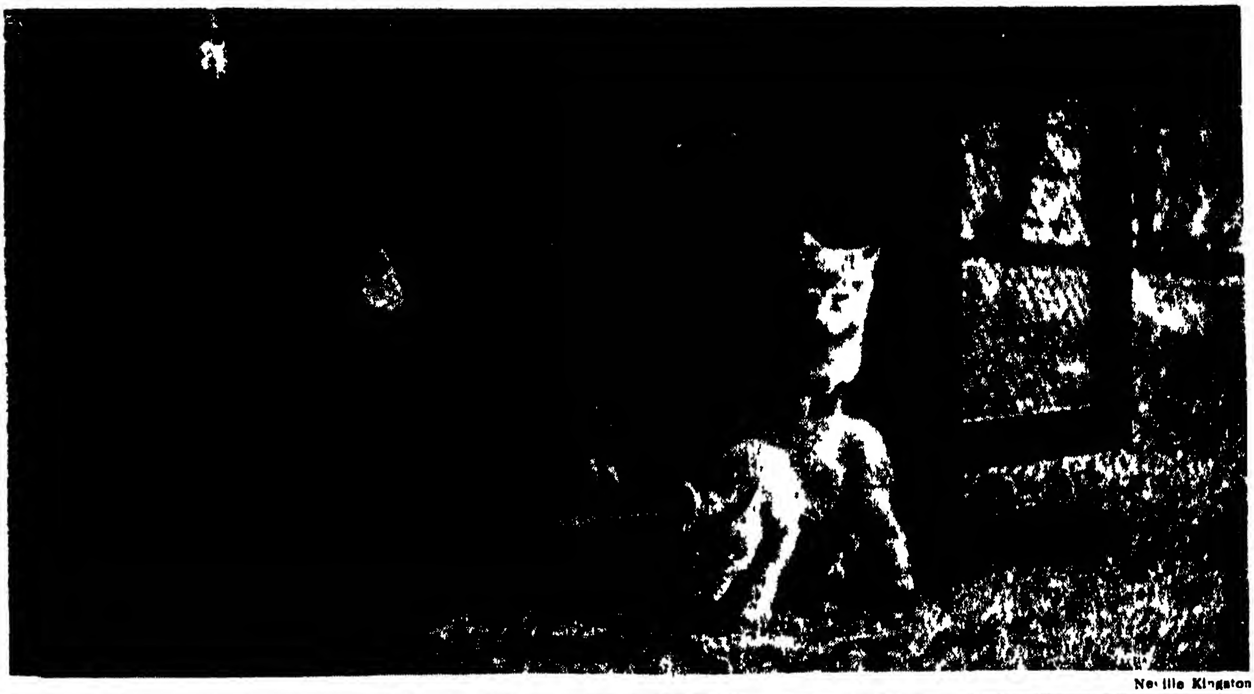
When one of the great cats condescends to tolerate the weak the result is impressive indeed. At the Zoo a certain cat named Rusty (bottom) took to going into the cage of Rajah, one of the tigers. Why this particular cat was not afraid, and why this particular tiger did not resent such impertinence is hard to explain. Laziness may induce tolerance. Witness the lion (top) that, while dozing, noticed a cock sparrow in its cage and rolled over on its back—that being the movement involving the least trouble—to watch the little bird

Keystone



GOAT AND RHINOCEROS DWELL TOGETHER. DEER LIVING WITH HARES

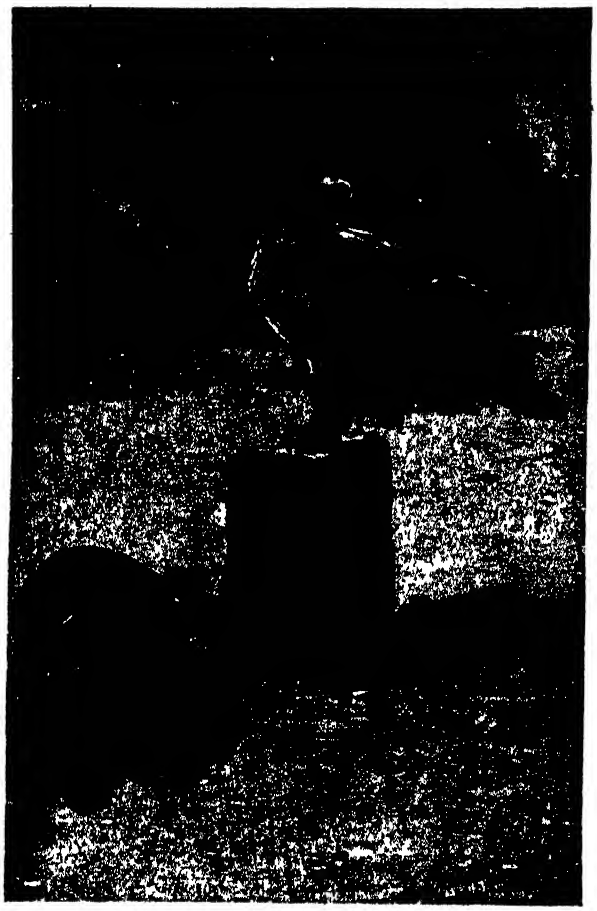
Goats have in all ages been regarded as rather mysterious creatures, and it will be remembered that they were always associated with the great god Pan A young mountain goat (bottom) discovered a playmate in an infant rhinoceros and the two would romp together till exhausted, only it was always the rhinoceros that got exhausted first Whereupon, the goat would take up its stand upon its friend's back and assume a threatening attitude Above we see a queer association between deer and hares at a Paris Agricultural Exhibition



Neville Kingston

GOOD COMPANY: FOX AND KITTEN, LURCHER AND WOLVES

Fox cubs are hard to beat for playfulness, but kittens make good rivals to them. The pair in the lower photograph provided much entertainment for their owners as they played at hide-and-seek or battles to the death. But the rules of mock warfare were never transgressed. An unusual combination of domestic dog and wolves appears in the top photograph. An English lurcher took upon itself the guardianship of some young American prairie wolves. All dogs originally descended from the same ancestors as the untamable wolf.



E N A.

DOG AND EAGLE FRIENDS IN HUNGARY

From Hungary comes the remarkable photograph of a dog which made friends with the fiercest of the birds of prey, an eagle. The eagle had a block of wood to perch on and the dog used to lie down beside it and appeared to like the strange company.

and more rarely of the solicitude of a cat for a nest of young rats, or a rabbit for motherless chickens. These, of course, result from the cravings of the natural maternal instinct, and it is doubtful if they survive the stage of helplessness.

A TERRIER which lived at Dunrobin Castle in Sutherlandshire had a family of puppies which were destroyed. She took up with a brood of ducklings, carried them off one by one to her kennel, and would allow no one to remove them. When, later, they made their way instinctively to water and plunged in she showed the greatest concern, evidently fearing that they would be drowned, as her own puppies had been. As they returned to the land, she picked them up one by one and took them back to her kennel. The same terrier, on losing another litter, seized two cockerel chickens, which she " brought up " with the same care as she had bestowed on the ducklings. But their attempts to crow proved a source of such annoyance to her that she was glad to resign her charge in the end.

The firm of Messrs. Hagenbeck, of Hamburg, so long famous for the supply of wild animals to zoological societies and shows, has for many years made a specialty of " happy families " of the largest carnivora in single cages. Lions, tigers, leopards, jaguars and large boarhounds are placed together, but it has been observed that these merely tolerate each other, with the exception of the dogs, which strive to introduce a spirit of camaraderie. Only the other day a serious situation arose in a circus in the North of England, in the arena of which a number of lions and tigers were being put through their paces. A lion snapped in passing at one of his striped companions, which at once joined battle with him, and in a moment the entire pack had lashed itself into a frenzy of savage rage, to the terror of the audience, who, however, were duly protected by iron barriers. Only the menace of burning torches served to separate the ferocious combatants and drive them from the ring.

IT would not do to conclude such an article as this without some reference to animal affinities in folklore. In many countries the people have long believed that certain beasts or birds have a strong affinity for each other, and that in some cases they afford mutual protection, a fallacy which in certain instances has been disproved only after long observation. Thus the common notion that crows and seagulls are companionable simply because they are frequently in the habit of gathering together in one field, is based on mere imagination only. The fact is that both species of birds are attracted to fields where seed has been sown by a common rapacity and nothing more, and that they tacitly ignore each other is obvious to anyone who observes them for more than a few minutes.

The old notion that dogs frequently join wolf-packs in countries where the wilder species is common, is equally groundless. No dog would be tolerated in a wolf-pack, and would, indeed, be torn to pieces the moment he showed himself. The oft-told tale that the South American puma has an affinity for mankind, and occasionally follows him out of a desire for companionship, has certainly more to commend it, and seems to be founded on fact.

That badgers and foxes frequently occupy the same earth is well known, but that anything in the nature of companionship occurs between the species is more than doubtful. Mutual toleration there may be, but nothing more. The same may be said of the owl, and the American prairie dog, which share burrows.

The conclusion to which we are bound to arrive at is that animal friendships are based on mutual aid, and that only occasionally do individuals of different species grow companionable out of a freakish liking for one another, which is probably aroused by contiguity and long association. But that these latter cases more commonly occur between domestic animals is obvious, instances of comradeship between wild species being almost unknown, unless based on the law of mutual assistance and convenience: and even then only in circumstances which would have to be described as exceptional.

Chapter XXXVII

The Skill of the Spider

By Susan Finnegan

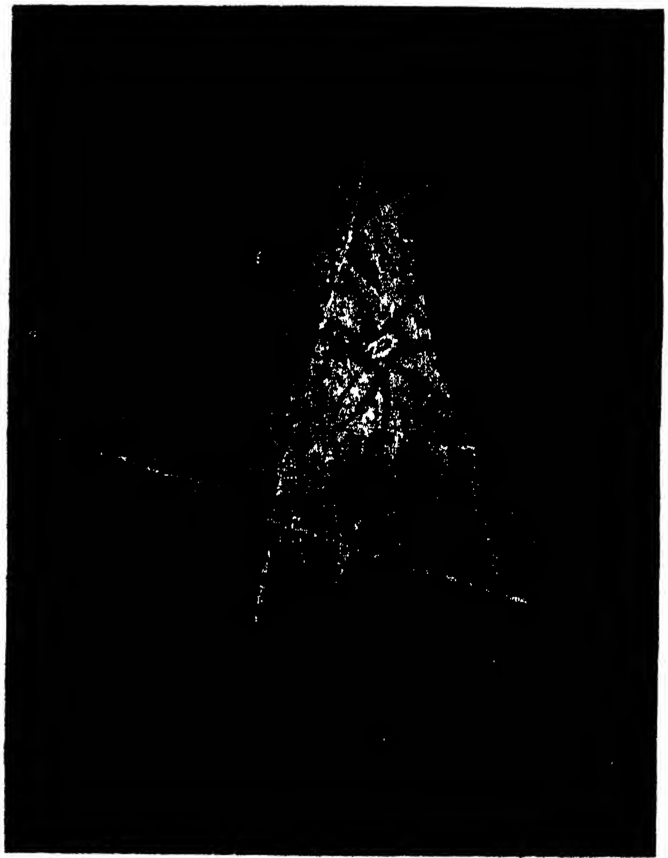
of the Natural History Museum, South Kensington

MANY stories and superstitions have gathered around the history of spiders, and one of the earliest occurs in Greek mythology. Arachne, the daughter of Idmon of Colophon in Lydia, a dyer in purple, acquired great skill in weaving; her patterns were so beautiful and her work so faultless that at length she ventured to challenge the goddess Athena. Athena was displeased at what she considered the presumption of a mortal, and took as the subject of her work her quarrel with Poseidon, intending it as a warning to such as dared to pit themselves against the immortals. Arachne chose the metamorphosis of the gods and illustrated their adventures. When Athena discovered that there was no blemish to be found in the work that Arachne had done, she took it up in rage and tore it to shreds. Arachne in despair hanged herself, but the goddess in seeing this had compassion and loosened the rope so that it formed a cobweb and Arachne changed herself into a spider, continuing to spin.

This story refers to the superior skill of Asia over Greece in the art of weaving. It also focuses attention on a habit that is fundamental in the life of all spiders — the production of silk and the art of weaving. It is undoubtedly due to this, and the varied uses to which the silk can be put, that spiders have secured such a hold in the animal world. They extend over the whole of the globe except in the extreme north and south, and have adapted themselves to all kinds of surroundings and habitats, from deserts to marshy plains, mountains and valleys, freshwater ponds and the space between the tide-marks of the sea-shore.

There is only one constant use to which all kinds of spiders put their silk, and that is the production of a cocoon for their eggs; this is the primary function. The eggs are enclosed by the female in a case of silk which may either be spun loosely around them, forming a flocculent seamless mass, or the cocoon covering may be spun in two parts, the eggs being laid on a sheet of silk previously woven for them and then enclosed by an outer covering which is swathed around; sometimes this has bits of gnawed bark and pellets of mud and clay introduced into it to strengthen the framework.

Although cocoons are constructed by all spiders and webs formed only by some, spider silk is more popularly associated with the web. This is natural, since the aim of the spider is to conceal the cocoon, rendering it as far as possible invisible to insects that would prey upon the eggs, while on the other hand, the web as a snare is often exposed and therefore more easily observed and reported upon.

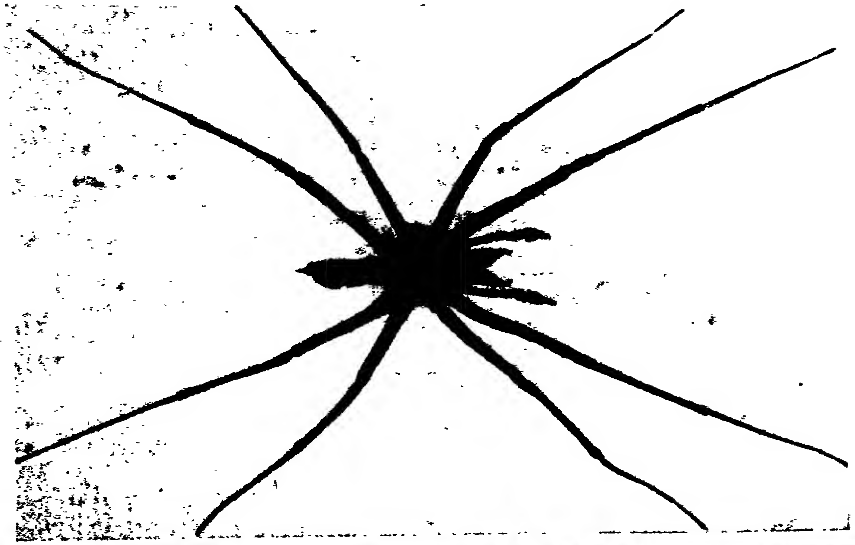


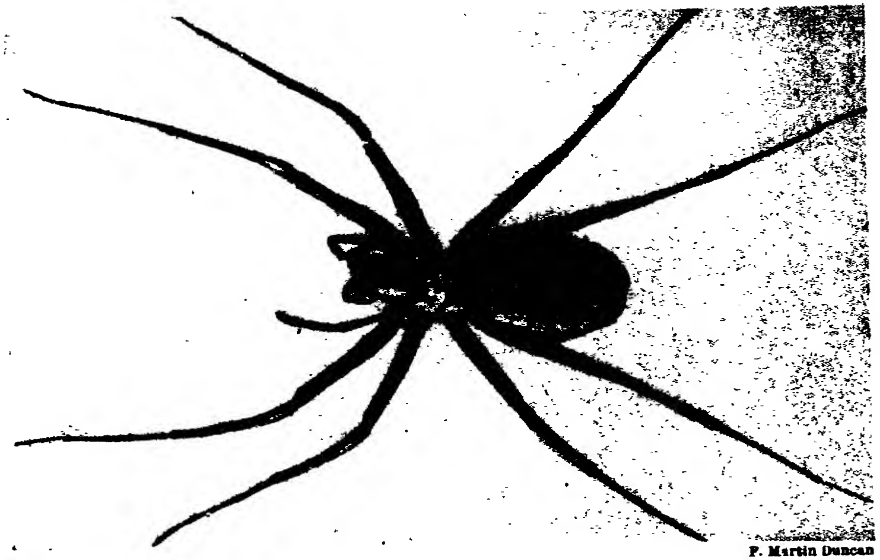
M. H. Crawford

SPIDER'S NURSERY

Secure in a silk cocoon which she has woven, the mother spider deposits her eggs, storing the whole contrivance in some safe place. Sometimes small pieces of mud or bark are used to strengthen and stabilise the framework of this wonderfully constructed "nursery."

There are many different forms of webs, the sheet-web of the common house spider, *Tegenaria derhamii*, which forms such ugly, dusty cobwebs in the corners of unused rooms and outhouses; the beautiful wheel-like web of the garden spider, *Epeira diademata*, and the silken tubes of the trap-door spider. The evolution of these forms is interesting. From a simple, more or less horizontal, sheet of threads the common house spider constructs his web, providing it with a small tubular hole to serve as a retreat; *Angalena labyrinthica*, the labyrinth spider of the countryside, has also an extensive horizontal sheet built among gorse or rough grass, but the tube in this instance is more complete, actually forming a tunnel through which the spider can escape into the vegetation below. But the *Lycosidae*, or wolf spiders, to which the true





P. Martin Duncan

John T. Roberts

A. M. Smith

BEST KNOWN OF WEB SPINNERS: GARDEN AND HOUSE SPIDERS AT HOME

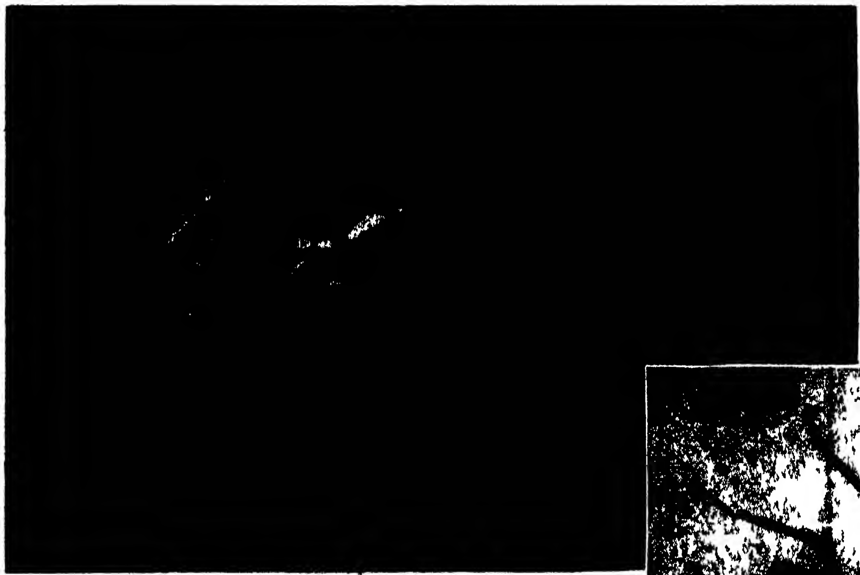
Both lower photographs show the round plump-bodied garden spider of Britain, which sometimes catches one's face with its threads, hung invariably between bushes or among low branches. The upper photographs are (left) of the male and (right) of the female house spider, which is responsible for the housewife's bane, the dust-collecting cobwebs. The male, we notice, has longer legs than the female, and he needs them to escape being eaten by his "intended," when he goes wooing. The female, on the other hand, is the larger of the two. It is interesting to recall that the female house spider, dipped in butter and swallowed whole, was held to be a certain cure for the ague in the Fen country, when that complaint was common in those parts.

tarantula belongs, and a very different group, the Mygalomorphs, which are great tropical spiders, both have their retreat underground.

The tunnel which they burrow in the earth is lined with silk to prevent the infall of loose soil or mould, while the aperture may either have a portion of the tube extended through it to the outside or may be closed by a hinged door which can be opened only from the inside, but is securely closed on the outer side. This is often coated with débris to match the surroundings so closely that it is almost impossible to detect the existence of the trap.

But there is another line of development; instead of the tube we may get mechanical skill employed to a very high degree in the construction of a sheet of threads in such a manner as to form the delicate wheel-like web of an orb-weaver like *Epeira diademata*, the common garden spider. This perfect orbicular web is built by the spider stretching a horizontal thread across to two neighbouring objects, and allowing itself to drop down from one end of the line to a point of attachment below. It then climbs up, crosses the horizontal line and drops down on the other side, laying down three lines of the quadrangle in this manner; to complete the fourth line it climbs up the one just secured, crosses the horizontal line once again, drops down the other perpendicular line and draws the thread across, making the quadrangular framework. Next the corners are joined and the radii laid down with great exactness.

The spider then returns to the centre of the web, and moving outwards to the circumference in a spiral it lays down a temporary scaffold of concentric lines. From the circumference it retraces its way to the centre, this time laying down a viscous thread with great deliberation; this spiral crosses each radius approximately at right angles. The thread is broken off at a short distance from the hub and the spider disposes of the temporary scaffolding by rolling it up and eating it. Finally the notched zone is added, which consists of a few turns of spiral, the thread of which leaves each radius slightly below the point of original attachment. Passing back from the centre of the web to the underside of an adjoining leaf, or some other situation chosen by the animal for concealment, there is a single thread, the trap-line, which communicates directly with the spider. By this means the spider has passage to the web, or if menaced by some danger it can drop easily to the ground, still retaining its attachment.



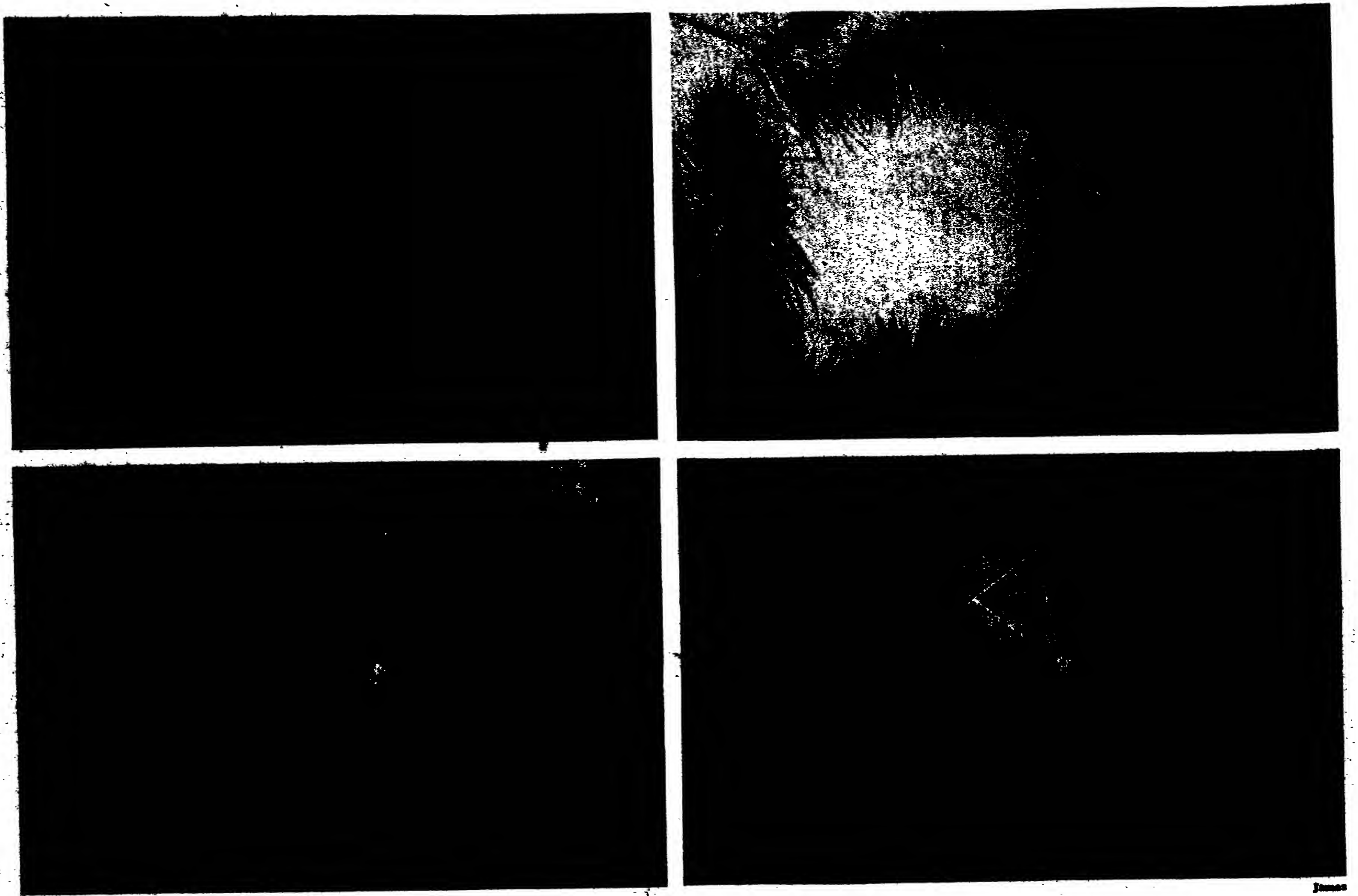
J T Roberts

SPIDER MOULTING AND SPIDER SPINNING

Here (top) is a garden spider paying out the silk from its spinnerets Notice that the line, as seen against the light, is covered with sticky globules. When the house spider moults (bottom) it has to disentangle its old skin from the web as we see here.

The web has great elasticity, which resides not only in the silk itself, but is increased in some species by the removal of the centre, which has the effect of easing the strain on any one particular spot. Wind can be a source of considerable annoyance, and the means taken by the owner to overcome this difficulty is to drop to the ground and after appropriating a very small stone or some suitable piece of debris, actually to secure it to the end of the thread to serve as a weight.

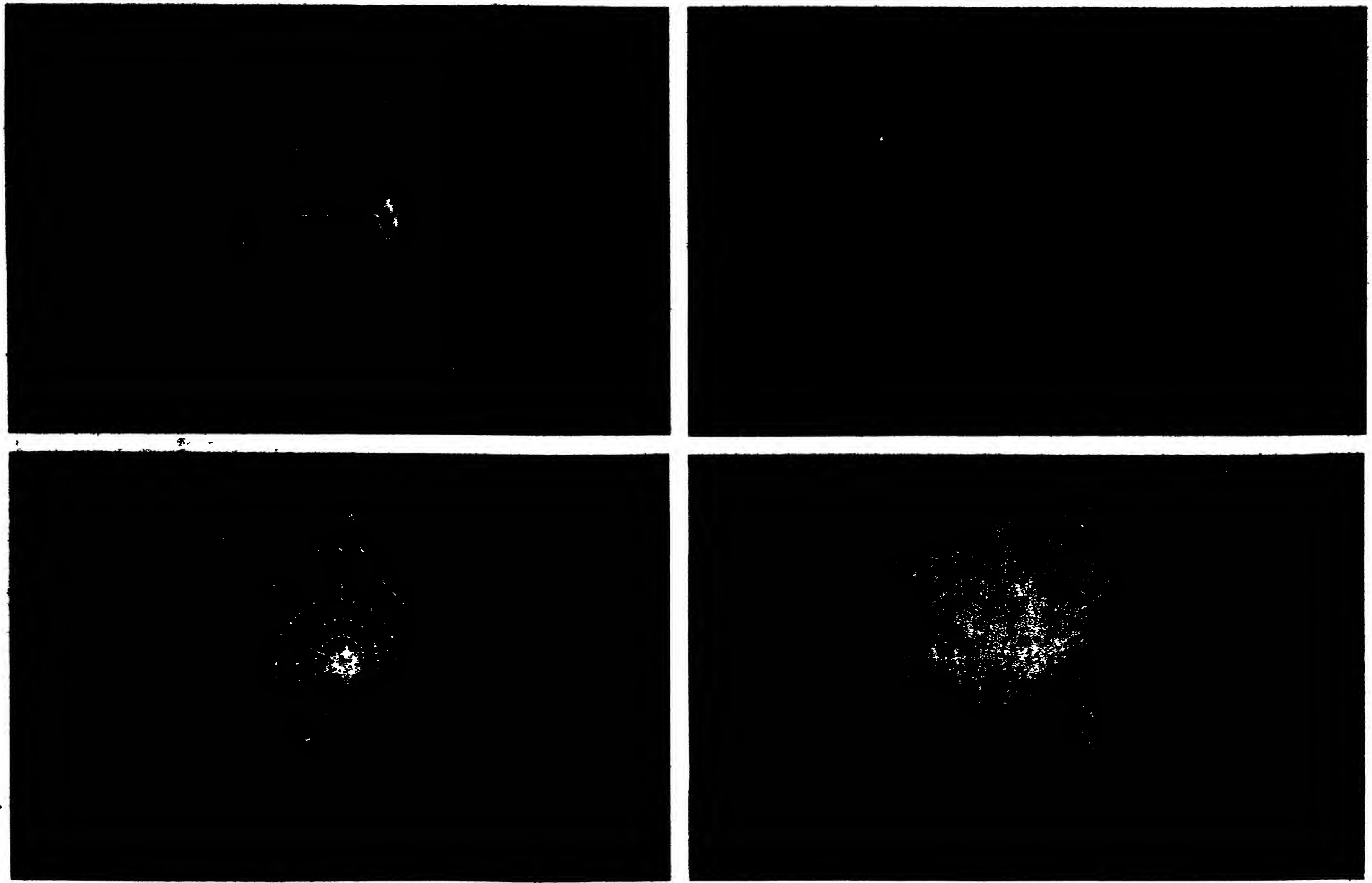
Spiders have another use for their silk which not only is of immense value to themselves but also has resulted in much speculation among people from a very early time. About the month of September or the early part of October, the young spider climbs up a stalk of grass or takes its position on the top of a



James

PHOTOGRAPHS AND DIAGRAM OF THE EARLY STAGES IN THE CONSTRUCTION OF A SPIDER'S WEB

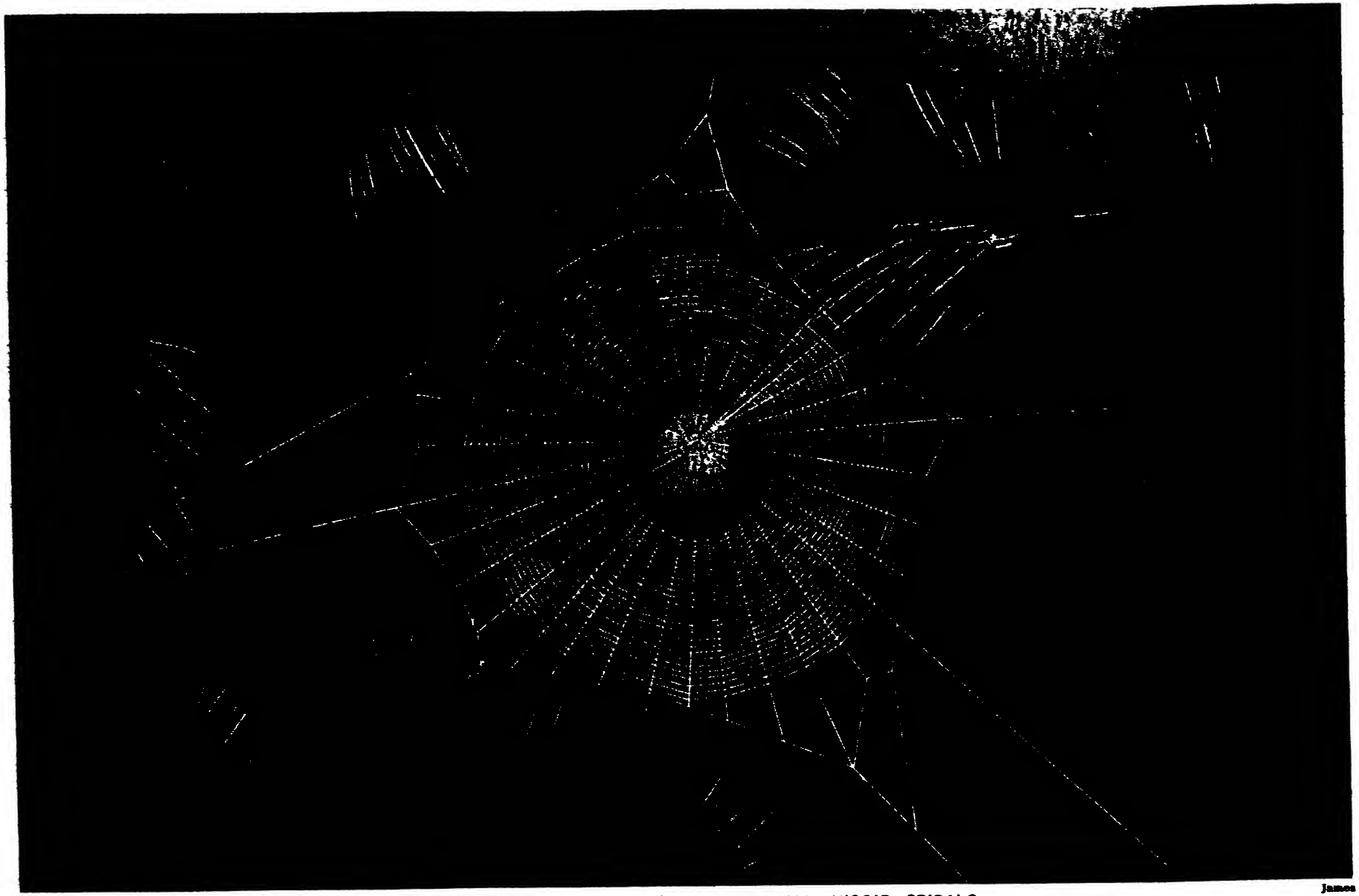
The spinning of a spider's web is no matter of an orderly procession round and round a circle with the threads laid down in rotation. The numbered diagram (top left) shows the order in which the threads were actually laid down in a web which came under scientific observation. The spider starts by emitting from its body the liquid which, solidifying immediately on contact with the air, at once adheres to the leaf or branch which the spider has chosen for the beginning of the operation. It then either crawls to another point or lets out a light thread which is caught by air currents and so wafts the spider to some other suitable support. Thus the initial line of the web is stretched between two points. Then it crawls back along this initial line (top right), making a stronger cable.



James

LAYING DOWN THE RADII AND BEGINNING THE SPIRAL OF THE WEB

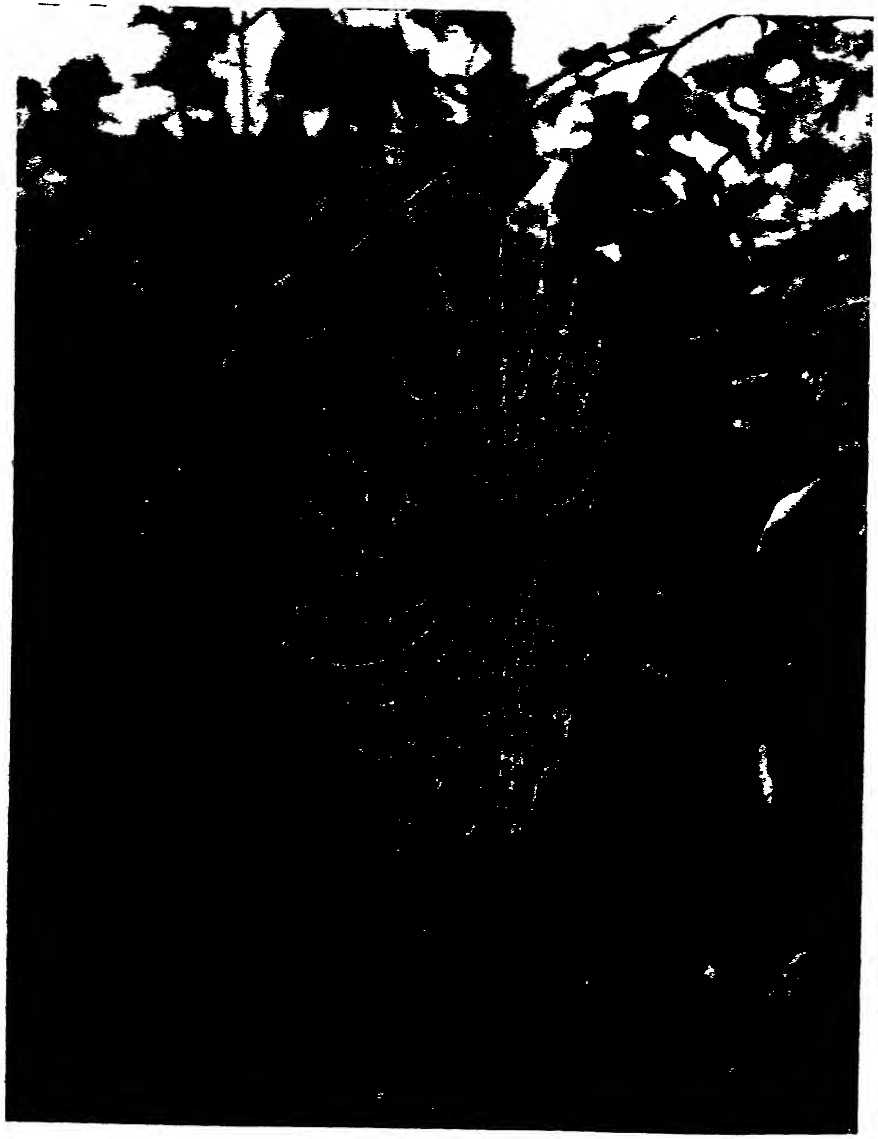
So soon as the first line is made the spider drops others, one from each end, and either joins these two to form a triangle or continues the process until the framework is a trapezium or a polygon and, having tested the strength of each line, has the framework complete. If necessary, additional supports are run off to convenient points of attachment. Then, starting from some point on the frame, the spider starts to walk round, paying out a line which it carefully holds clear of the frame. When it has reached a point opposite to the start of its walk the spider hauls this new line taut. Thus the framework is bisected by a diametrical thread. The mid-point of this then becomes the starting-point for a number of radii or "spokes" from the centre to the framework.



James

WEB ALMOST COMPLETE WITH ITS DEADLY VISCID SPIRALS

When the radii or "spokes" have been completed the spider goes to the centre and plucks at each line to test it. Then a spiral is spun about the centre to steady the whole web, and the transverse threads are laid down. These, when first emitted by the spider seem the same as the rest of the web, but soon begin to assume a stouter appearance. This is due to the fact that the transverse threads are coated with a viscid or sticky substance, so that any insect striking the web will adhere to it. It appears that the spider excretes some special antidote to the sticky properties of the transverse lines or "viscid spiral" of the web so that it does not get caught in its own trap.



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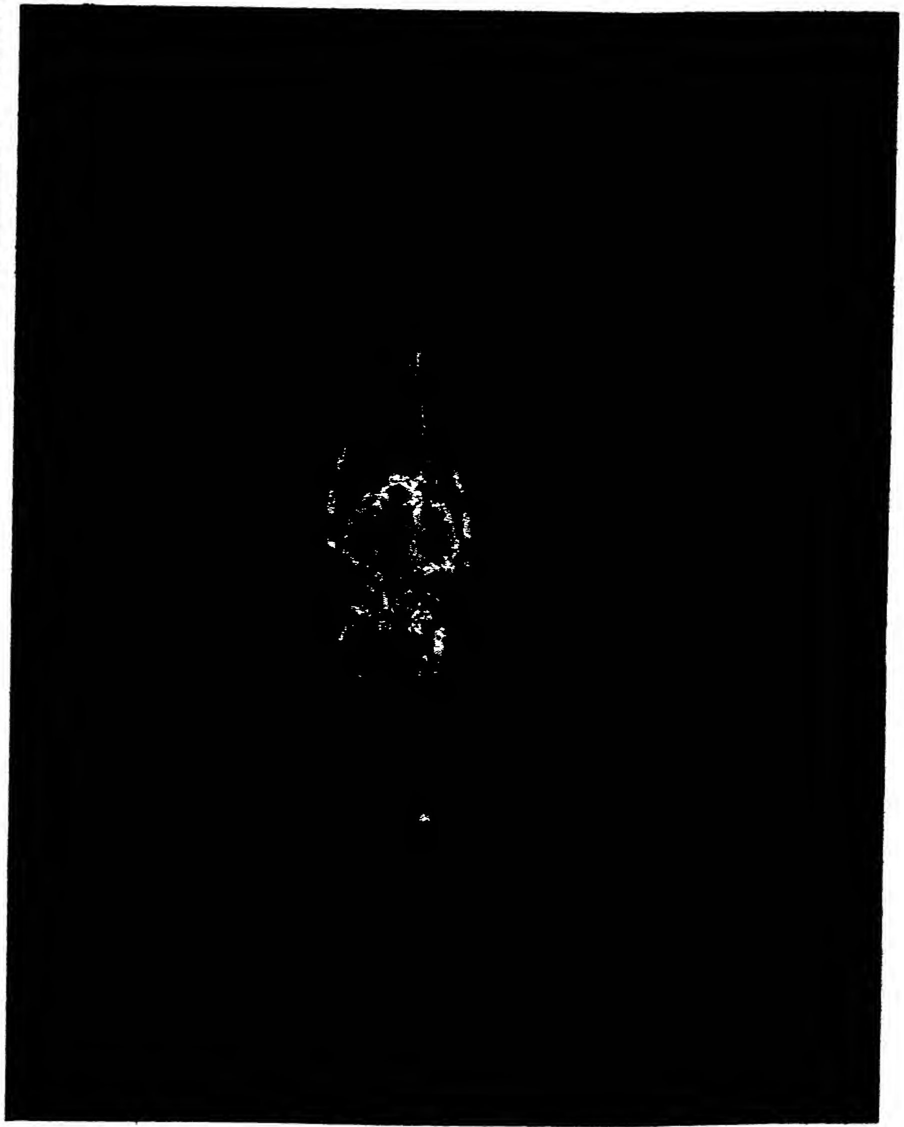
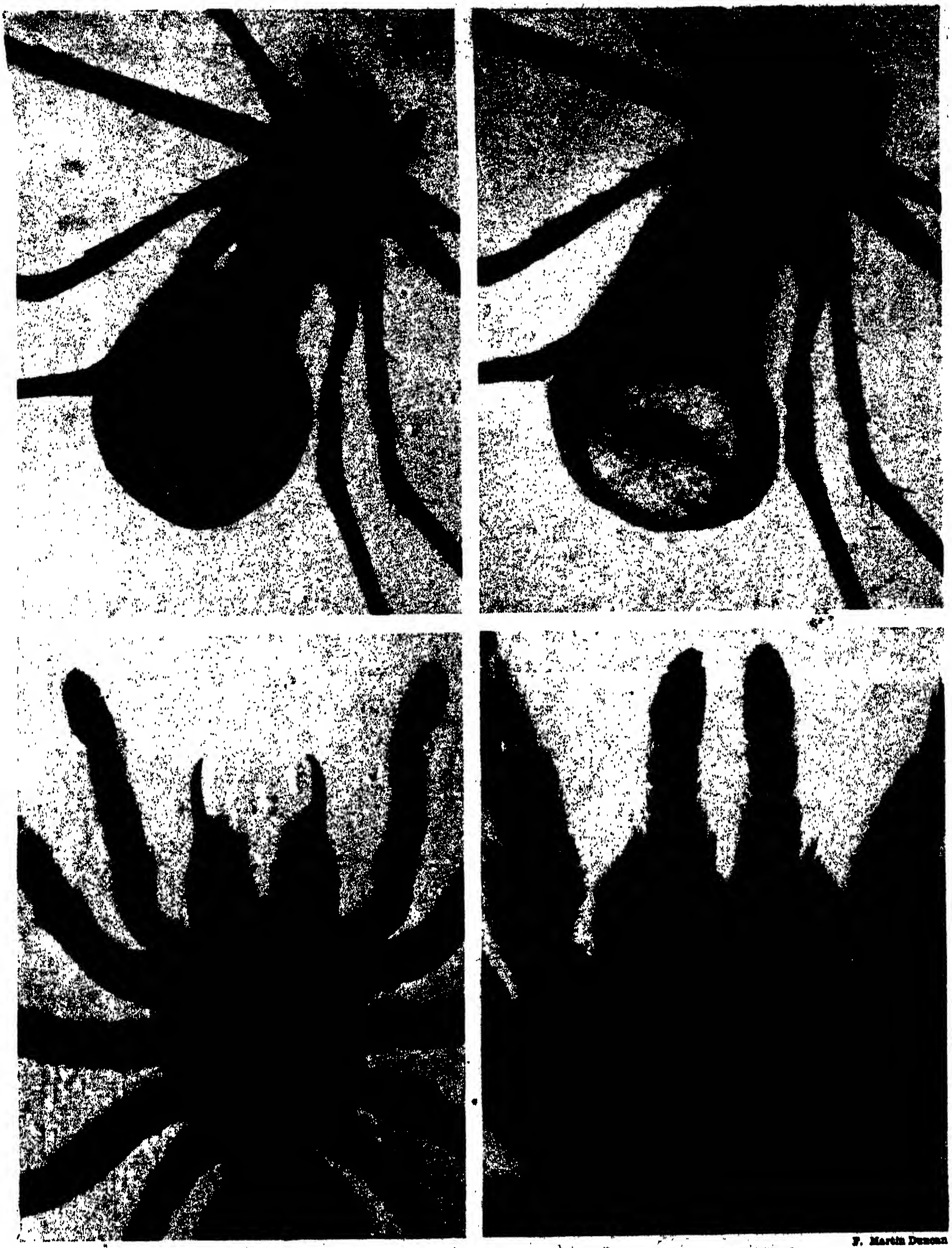


J T. Roberts

WEB CAUGHT BY MORNING DEW AND BEING REPAIRED AFTER DAMAGE

Our attention is most strongly drawn to a web in the early morning when the dew upon it catches the sunlight (left) forming a shining silver net It must be remembered that the spider has to allow for all this extra weight of moisture, and, indeed, the silk of which the web is made possesses the most extraordinary elasticity and strength Not only has dew to be provided against, but wind also The spider, wise from experience, often cuts away the central nucleus of its web in order that the wind resistance may be lessened where the pressure is strongest The right hand photograph shows a spider in this central part, very busily employed in making rapid repairs after damage by some mischance



F. Martin Duncan

HEADS, FANGS AND COCOONS OF THE VERSATILE RACE OF SPIDERS

Mygale spiders are large in size and found in the tropics. The Californian mygale (bottom left) has downward curving jaws which enable the creature to strike home with its poison fangs when it jumps upon its prey. The Brazilian mygale (bottom right) is known as the bird-eating spider as its poison can kill a small bird in a minute or two. These mygales do not trap their prey, but pounce on it on the ground or in trees. The huntsman spider of tropical and sub-tropical regions is born in a cocoon carried by the female. The upper photographs show (left) the underside of the cocoon and (right) the upper side and its beautifully fitting lid.

fence; it then jerks its abdomen up into a vertical position, at the same time emitting a streamer of silk filaments from the spinnerets (or spinning organs). These are caught by the wind and drawn out into threads of considerable length; if the current of air is favourable and the thread trustworthy, the young spider sets afloat in the air; by this means it may be carried many miles, even by moderate winds.

This habit is of value to them as means of dispersal and is probably one of the most important factors in securing their present wide distribution. It has stimulated speculation very naturally among those who have observed the large sheets of gossamer carried by the wind and at length deposited on fields and hedges, or on the rigging of ships far out at sea. Many attempts are made by these animals before suitable conditions guarantee the safety of the undertaking, and so vast quantities of gossamer are set floating in the air.

J. T. Roberts

YOUNG SPIDERS AND EGGS IN THEIR COCOON

When the time for laying her eggs approaches, the female spider spins a silk cocoon and attaches her eggs to it (top). Within this nest the young spiders hatch out, while in certain species the mother spider remains inside with them. The first moult which the young spiders experience takes place within the nest, and then they bite their way out to freedom.

The nature of gossamer has puzzled many generations of observers; the word itself in the early form "Gar-summer" is supposed to indicate summer hoar, as opposed to winter hoar, and the frosty or dewy appearance presented by gossamer on the ground fostered this belief. Spenser's description in the Faerie Queene is often quoted in this connexion:

> More subtle web Arachne cannot spin;
> Nor the fine nets, which oft we woven see,
> Of scorched dew, do not in th'ayre more lightly flee.

And it is easy to understand how the idea of "scorched dew" presented itself to the poet's mind if we realize the effect of dew on sheets of gossamer on the ground, the dew later evaporating in the sun's rays, but the gossamer remaining as "scorched dew" to bear the heat of the day.

The elasticity of spider's silk, its gossamer fineness, have been proved to us by the creature itself, and its possible commercial value has often been considered. Travellers coming back from distant islands and the East have recorded its use among some of the peoples in articles of apparel, but one of the earliest accurate accounts of definite attempts being made on a commercial scale was by M. Bon, in 1709. He communicated to the Royal Academy of Montpelier that he had successfully manufactured a new material from silk obtained from spider cocoons and presented them with several pairs of elegant stockings and gloves. The Academy investigated the question thoroughly, but found that as a commercial undertaking on a wide scale spider silk would be unprofitable, for not only are a very large number of

spiders necessary for the production of any quantity of the material, but the cannibal tendencies of the animals themselves make it impossible to put it on a good commercial basis.

The various devices adopted by spiders in building their webs indicate the different methods employed by them in capturing their prey, for their skill as hunters is no less than their skill as architects. The Lycosids and Mygalomorphs excavating their burrows in the ground demonstrate two independent lines of action. Where there is an external inflated portion of the silk tube that lines the burrow, the policy favoured by the hunter is to wait till an insect alights on this, then the spider rushes out, grabs it from within and draws it into the burrow, where, after making a meal of its catch, it mends the torn portion of the tube if necessary. Where, however, there is a definite trap-door to the tube, the spider goes about securing its prey in a more predatory manner. Cautiously it lifts the flap of the burrow and peeps out, and when an insect comes within sight and grasp, it springs out, catches it and drags it in, the elastic hinge of the trap-door closing the flap securely behind them.

James

H S Cheavin

SILK FACTORIES OF SPIDERS

At the hinder end of the abdomen in spiders are the spinnerets, complicated organs covered by a number of minute tube endings which emit the secretions which make the silk (Bottom) house spider's spinnerets; (top) garden spider's.

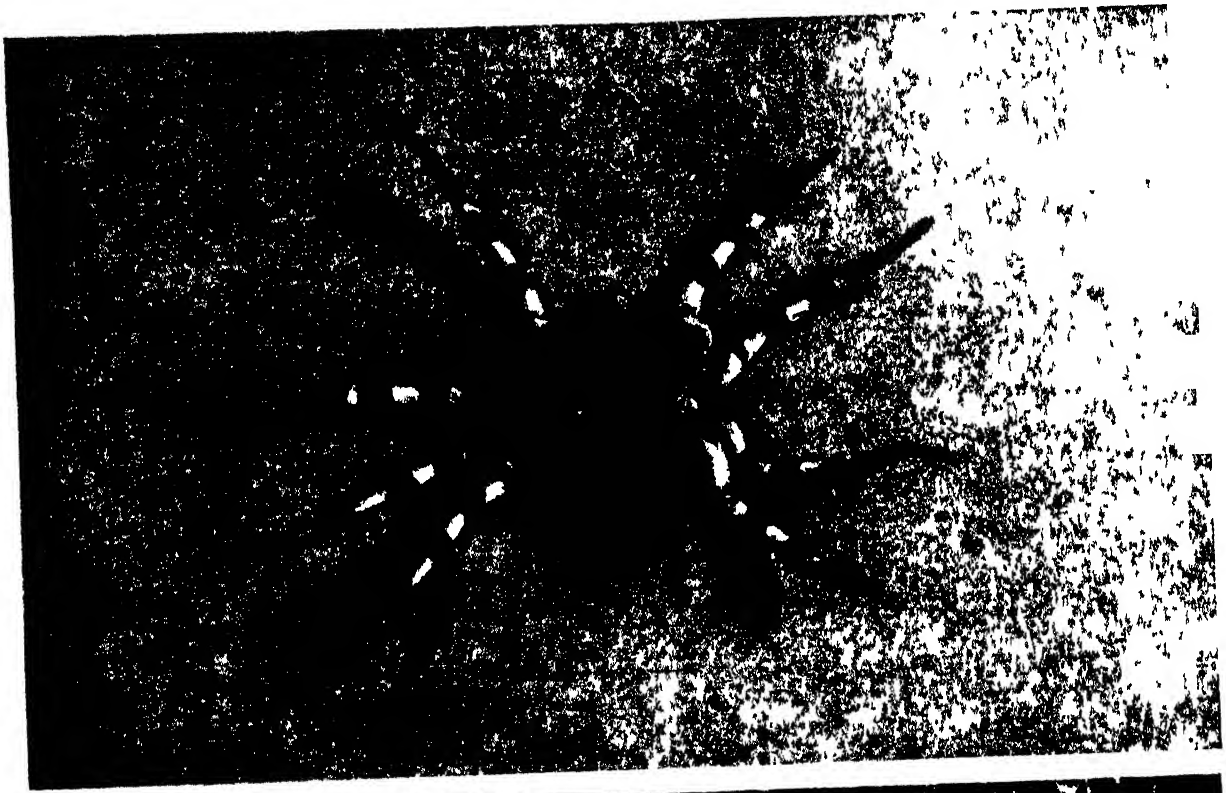
F Martin Duncan

H S Cheavin

SPIDERS' WONDERFUL FEET

The house spider (bottom) has the toothed claws of its feet more curved over than the garden spider (top) The foot of the latter is covered with hairs to form a kind of comb for drawing out and holding the silk when web making.

Spiders that build their snares in the open do not conform to one line of action, either; *Tegenaria derhamii*, the common house spider, lurks in the tubular portion of her sheet of silk and the vibration of a piece of straw skilfully applied on the web, brings her running out to secure the prey. *Epeira diademata*, with her complex orbicular snare, can dart with certainty from her place of concealment to the exact spot where an insect has entangled itself; the vibration travelling along the trap-line brings the spider rushing to the hub where the vibration of the particular radius is perceived and the exact position of the insect located. The great tropical Nephilids, with their immense, strong webs, have as their prey animals often much larger than themselves, many observers recording small birds and even snakes hopelessly trapped. One story which would seem to indicate that web-weavers do not always wait for



F W Bond

HAIRY BIRD-EATING SPIDER AND THE ONCE-DREADED TARANTULA

The lower photograph shows a bird-eating spider of South America. The extreme hairiness of the creature is due to the fact that it has just moulted its skin. Soon after this change it loses much of its hair. Above we see the famous tarantula, named after the city of Taranto in Italy, where it is common. It belongs to the family of the wolf spiders. In medieval times and until recent years hysteria was supposed to be caused by the bite of this spider. A special dance called the tarantella was invented to cure people of the supposed effects

I F

[illegible] occasionally try to assist it, is that of a small spider, unfortunately not accurately determined, passing filaments of silk threads around the tail of a mouse which had stationed itself below the web. All the struggles of the mouse were of no avail, as it was very slowly and gradually hoisted up by the spider till finally its whole body was lifted from the floor and drawn up some inches off the ground.

As was mentioned earlier, all spiders do not weave webs, and these stalk their prey, as a cat does a mouse. *Epiblemum scenicum*, the zebra spider of this country, may often be seen on a sunny day running along a fence with cat-like movements. When the insect is sighted it stalks it carefully, keeping its great shining eyes fixed on it and running with hesitating movements; finally it leaps and drives its mandibles deep into the victim. Before this leap the precaution is taken of providing a means of swift return by attaching a silk thread to the point from which the jump is made.

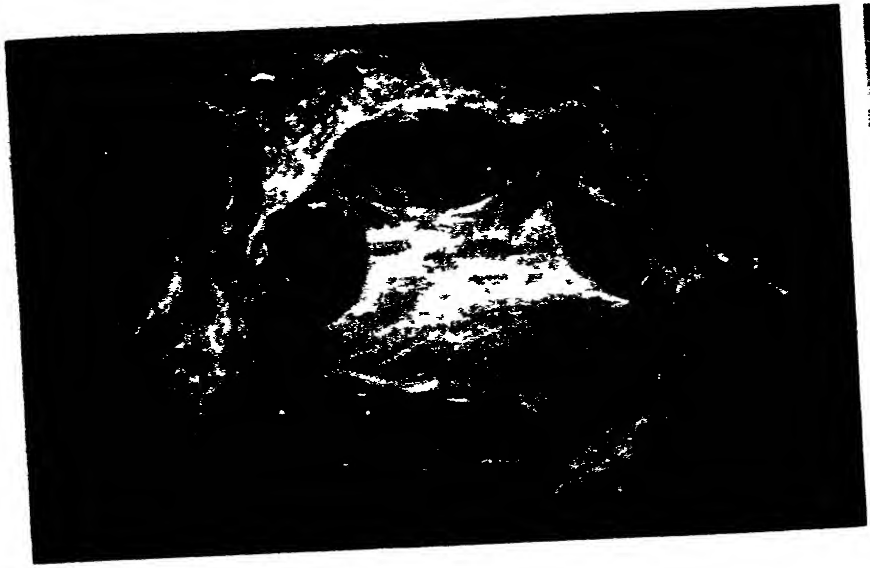
What of their skill in evading the hunters when they themselves are the destined victims? There are, in particular, three ways of avoiding pursuit: they can seek a habitat unfrequented by their natural enemies; they can escape observation either by close resemblance to their environment, or by mimicry; and finally they can render themselves distasteful to their enemies.

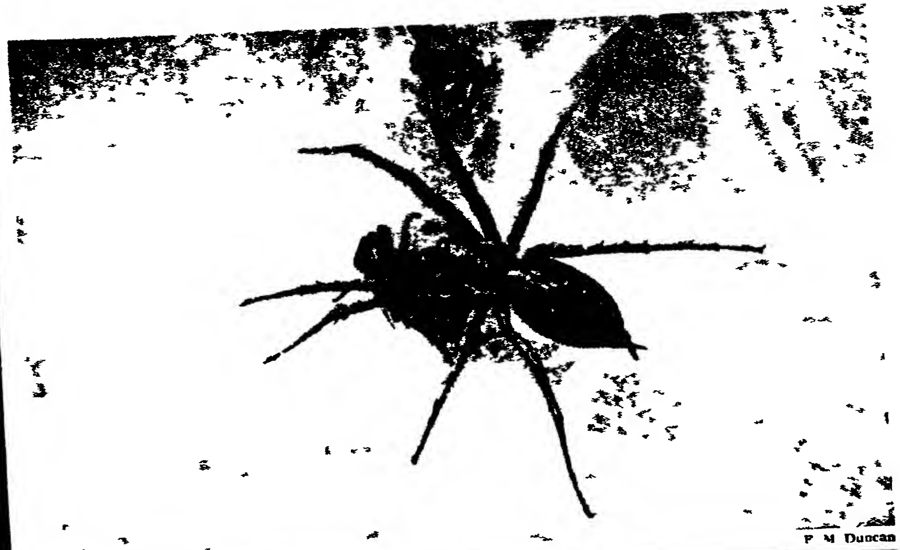
SPIDERS have adapted themselves to many varied habitats. They are to be found in desert wastes, in marshlands, in fertile valleys and at high altitudes on the barren mountainside, and they may even be found, like *Agyroneta acquatica*, spinning their nests under water. This animal has overcome the difficulties of living in the unusual element by taking down with it as it plunges, a film of air; the air is retained by the hairs of the body and released by the spider when it reaches its home, by passing a leg over the hairs and practically combing it out into the thimble-shaped web until that is full of air, and fit for the spider to take up its residence in. The few marine spiders that we know living between the tide-marks of the seashore retire into a crevice which they have rendered watertight until the tide has ebbed and they are free once again for a few hours.

F. Martin Duncan

FORMIDABLE JAWS OF THE ZEBRA SPIDER

Of the jumping spiders the commonest British species is the zebra spider. It is handsomely striped and may be seen running along fences or garden walls. It stalks its prey like a cat and finally leaps upon the luckless insect, driving home the terrible jaws illustrated above. Before making the fatal and final leap the spider takes the precaution of attaching a silk line to the "take off" of the jump, so that a swift return can be made, if such should be necessary.





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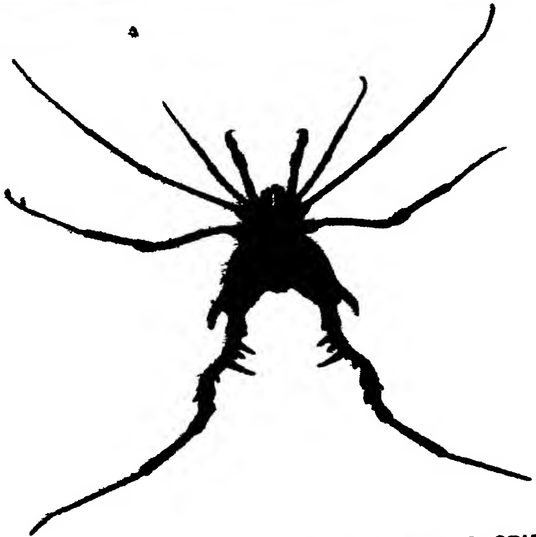
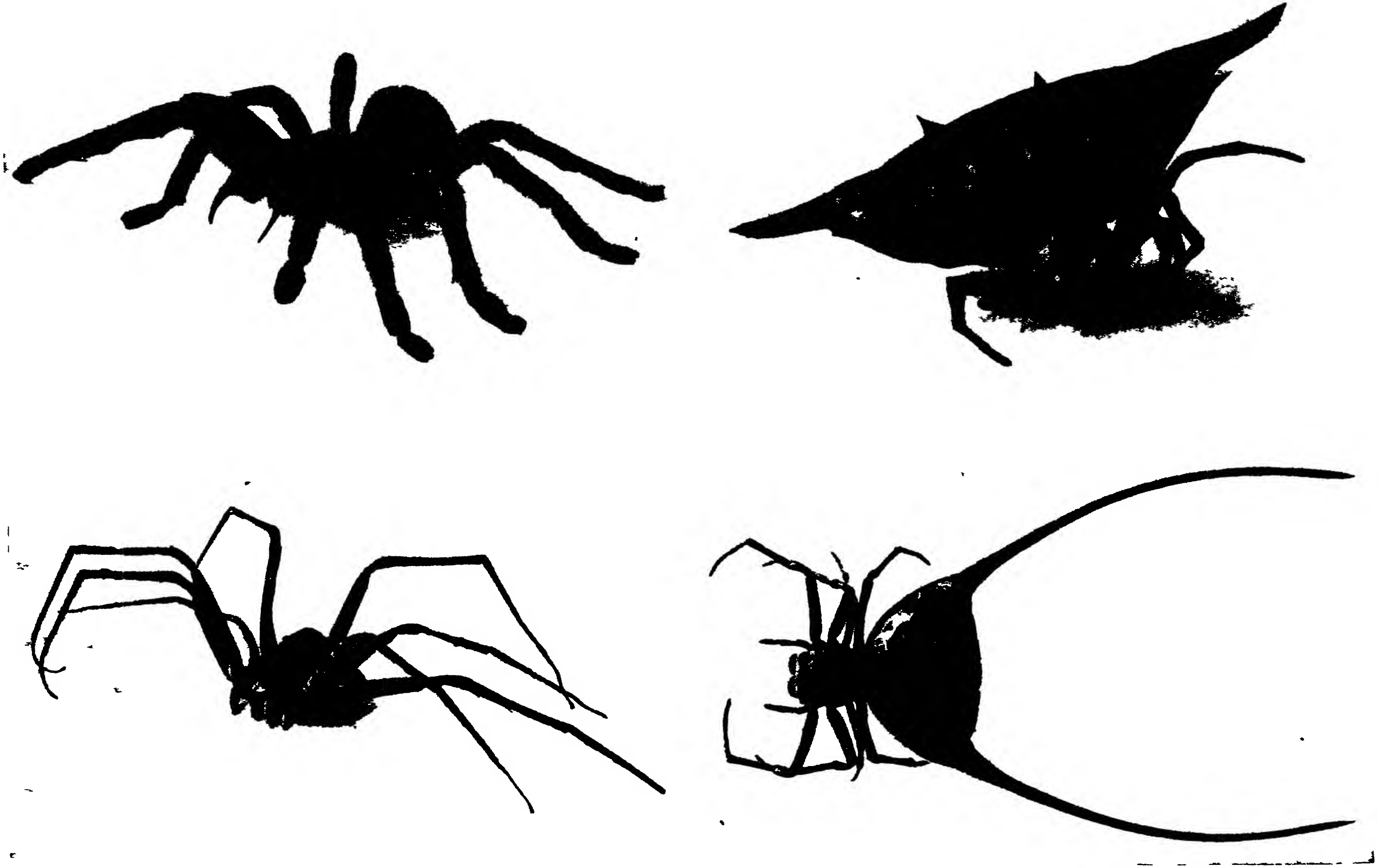


J T Roberts

SOUTH AMERICAN HARVEST SPIDER, WOLF SPIDER, AND A HEATH SPIDER SLAYING A FLY

Grotesque and fierce-looking, the South American harvest spider (bottom left) has its hind legs armed with spurs The wolf spider (bottom right) chases its prey and leaps upon it, and the female, as we see here, carries her cocoon of eggs about with her Some members of the family make a hole in the ground, where they lurk, while others have no home at all, but creep under some leaf or stone if they need shelter The upper photographs show how the heath spider spins a cocoon to hold its eggs (left), and (right) the fierce destroyer which has leaped upon a fly The fly is on its back, helpless, with its wings caught by the entangling, clinging web, and the spider is giving the death stroke with its fangs



F Martin Duncan

NEAR VIEWS OF FOUR STRANGE SPIDERS OF THE NEW AND OLD WORLDS

Huntsman spiders are remarkable for their aeronautic powers, travelling great distances by letting out strands of silk and allowing the air currents to carry them along. This habit, and the Trade winds, seem to account for them having circumnavigated the globe, so far as the Tropics are concerned. Here we have a female (bottom left) grasping her cocoon. The Tropics of both Old and New Worlds have the strange gasteracantha (bottom right) The Californian mygale (top left) hunts its prey and is armed with a pair of particularly deadly-looking jaws The remaining specimen (top right) comes from the Far East and has adopted protective mimicry, for its body resembles the seed of some spiny plant

Many spiders can be distinguished only with considerable difficulty from the surroundings in which they move; *Dolomedes fimbriatus*, one of our common marsh spiders, has on its abdomen two whitish yellow stripes that render it very inconspicuous among the rushes. The colour of certain *Thomisids* can be observed changing when the animal is removed from a pink flower where a pink colour was assumed, to a yellow flower with splashes of red, when these colours take the place of the former pink.

Numerous instances of mimicry occur in this group; of flowers, of knots on the wood of trees, and of twigs and sticks, but perhaps most remarkable of all is the mimicry of snails, beetles and ants. The enemies that spiders probably have most reason to fear are the solitary digger, or mason, wasps, which prey on them in large numbers, but do not attack ants; therefore it would be of the first importance to these spiders that the wasps should be deceived. So very accurately do the spiders mimic ants, that it requires much care to distinguish the model from the original, but the deception is carried further than the appearance of the animals, as the spiders have even adopted the motions and busy movements of the ants.

Sometimes spiders are passive in rendering themselves distasteful to their enemies, examples of which may be found among the *Gasteracanthids*, with their hard spiny abdomens; but the venomous species are armed with so formidable a weapon in their poison that few creatures deliberately provoke them.

So much for the relations of spiders with the outside world; it would be interesting to study the relations existing among themselves. Popularly, spiders are regarded as a quarrelsome lot in their domestic relations, but this is hardly borne out by the evidence. In the case of *Epeira diademata*, and many others, it is true that the male has to approach the female with temerity. When he comes to her web he gently strokes one of the threads, setting up a vibration which acts as a signal to the occupant, who regards him gloomily while he makes his advances. Ultimately, if he is patient, he may be allowed to approach, but should he lack this virtue the larger heavier female bears down upon him and devours him. On the other hand, the male and female *Agalena labyrinthica* are often to be found living together in perfect amity. Many Salticids however, provide their mates with amusement before venturing too near, by executing most intricate dances before them, waving the plumes that adorn them and displaying their brilliant colours during the dance very much as birds do.

Lastly, we should consider the relation of spiders to other groups in the animal kingdom. They belong to the division known as *Arthropoda* (animals with jointed legs), which includes so vast a congregation of insects, arachnids, crustaceans, and so on, that in numbers they would outrival all the other animals in creation.

[illegible] ivision, spiders, together with scorpions, [illegible] vestmen, form the class Arachnida, and are distinguished from other Arthropoda by having four pairs of legs. Spiders may in turn be distinguished from their nearer relations which are included in the class Arachnida, by having the two chief divisions of the body—the cephalothorax in front, and the abdomen behind—separated by a narrow "waist," and the abdomen (except in one small family) unsegmented.

The cephalothorax from the dorsal aspect is generally seen to have a median depression with lines radiating from it to the sides, indicating the attachment of internal muscles; the part anterior to these lines is the head region or "caput" often clearly marked off from the thoracic region. This portion bears the eyes, usually eight in number, but varying in size and arrangement. Ventrally, the cephalothorax is protected by the "sternum," a large plate variable in shape and notched on either side for the reception of the legs.

There are four pairs of walking legs, typically seven-jointed. The cephalothorax also bears the pedipalpi, six-jointed leg-like feelers, anterior to the legs; the last joint of the palp in the male is modified, and has a rounded bulbous appearance. Anterior to the pedipalpi are the chelicerae, or mandibles (not homologous with the mandibles of insects), consisting of a stout basal portion and a strong fang. The duct of the poison-glands has its opening near the tip of this formidable fang.

Some spiders are capable of producing humming or hissing sounds, and this is performed by the friction of two rough surfaces, which, when modified for this purpose are known as "stridulating organs."

The abdomen may be globular, pea-shaped, or very much attenuated, and may have additions in the form of spines, scuta and protuberances; it is unsegmented except in the small family *Liphistiidae*, from the Oriental region. On the anterior portion of the abdomen transverse slit-like openings (the spiracles) can be seen. These are the openings to the respiratory organs, the lung-books, which may either be two or four in number; in addition to the lung-hooks, tracheae are almost universally present, and generally have their opening just in front of the spinnerets.

Most characteristic of all are the spinning organs or spinnerets, on which the tubes of the spinning glands open; they are normally six in number and usually placed beneath the abdomen near its apex and anterior to the anal tubercle. Generally the spinnerets are arranged in three pairs. Sometimes there is an accessory structure, the cribellum, which is a sieve-like plate, and associated with this the fourth leg is provided with a series of stiff hairs, the calamistrum, whose function is to draw out the thread from the cribellum into a hackled band. *Amaurobius similis*, found on old pieces of timber in outhouses, has a web composed of such a hackled thread.

It is easy then to realize how so many diverse stories and superstitions have become woven around this extremely interesting group.

Chapter XXXVIII

Animals Man Has Tamed For His Use

By David Seth-Smith

Curator of Mammals and Birds, London Zoo

FROM a very early period man has tamed and made use of the lower animals to provide him with food, clothing, and draught power. His more highly developed brain has enabled him to bend them to his will, and right well have they served his purpose. By his skill in domesticating certain species that were fortunately suited to his purpose he has provided his race with food and raiment that could never have been procured in sufficient supply had he had to rely upon killing the wild animals. Without draught power he would have been unable to till the land and grow his vegetable food

There existed in prehistoric times a very large bovine animal in Europe known as the aurochs, which prehistoric hunters pursued and killed for meat. The calves were sometimes captured and tamed, and when they grew up, it was found that they took to captivity readily, and in their turn produced young, while from the captive cows milk was obtained. Hence began a domestic breed of cattle, while the wild animals became scarcer and scarcer, until they eventually became extinct. It is uncertain at what date the aurochs disappeared from Britain. In Scotland it lingered longer than in the south, while it was still abundant in Caesar's time in the Black Forest of Germany, and there is evidence that it still existed on the continent of Europe in the twelfth century.

There is little doubt that the aurochs was the direct ancestor of at least our largest breeds of domestic cattle. What its colour was is uncertain, though as the so-called park cattle, which are probably the remnants of captured herds of aurochs and have been carefully preserved in several parks in Britain, are mostly white it has been suggested that this was their colour. But as captivity and domestication frequently tend towards albinism, it is more probable that their owners had a liking for white specimens, and destroyed those of other hues.

FALCONER OF BISKRA

One of the most ingenious of man's adaptations of Nature was the training of bird to catch bird in his service. This is an Arab falconer at Biskra with his hawks hooded, one on his wrist and the other on his head. Hawking dates from at least 2,000 B.C.

There would seem to have been little difficulty in the process of domesticating cattle, for it has been accomplished in other species besides the aurochs. In India, China, Africa, and Madagascar, the cattle are distinguished from those of Europe by the presence of a large hump on the withers, and by other structural features, and voice, indicating that they have descended from some species that has long become extinct. In north-eastern India the gayal exists as a domestic species, and in Java the smaller form, known as the banting, has been successfully trained to the regular service of man.

In Tibet we find a species clothed with long hair to suit it for the rigorous climate, the yak. This also has been domesticated by the inhabitants, who use it both for food and clothing, and as a beast of burden.

Although there are many wild species of sheep, the origin of the domestic animals is clothed in some mystery. Domestic sheep, or, at any rate, nearly all of the breeds, naturally possess long tails, which are not found in any of the wild species. The wild animals, moreover, are clothed with hair, whereas their domestic descendants mostly grow wool. But of the existing wild species, those most closely allied to the domestic varieties appear to be the mouflon of Corsica and Sardinia, the urial of north-west India, and the Armenian wild sheep. The varieties or breeds of domestic sheep are very diverse in type, and very numerous, and it is possible that several wild species may have shared in their production It is possible that the production of wool instead of hair may be an acquired character due to selection.

The domestic varieties of goats are very numerous,

but it is probable that they were originally derived from the wild goat of Persia, though, since the various species of wild goat will readily interbreed, it is possible that crosses with some of these may have been partly responsible for the great diversion in type of the domestic races.

It is impossible to trace the date of the first domestication of the goat, but we know that the ancient Egyptians kept goats, and they were also possessed by the prehistoric inhabitants of the wonderful Swiss lake-cities

While several species of deer have been kept and bred in semi-captivity in parks, the only species which man has thoroughly domesticated for his use in providing him with food, clothing, and draught power is the reindeer, which inhabits the northern regions of both the eastern and western hemispheres, being known in America as the caribou. It is specially provided by Nature for a life on the snow, the hoofs being large and able to spread to give a good foothold. It is a somewhat heavy and strong animal, and has been made use of in Siberia, Lapland, and part of Norway. It has become indispensable to the life of the Laplander, to whom it serves the purpose of horse, cow, sheep, and goat. Being capable of hauling considerable weights, and possessing a remarkable power of endurance, it is harnessed to a sledge and is able to travel hundreds of miles over the snow. Its flesh and milk are used for food, and its skin for clothing, while a somewhat larger breed in Northern Asia is used also for riding.

The Arabian or one-humped camel became extinct as a wild animal so long ago that its original habitat is a matter of conjecture, though it is generally believed to have come from Arabia. Fossilised remains have, however, been found in the Pliocene rocks at the foot of the Himalayas, which seems to indicate the possibility of India being its original home. Be that as it may, the camel is one of the most valuable of domestic animals, and indispensable as a beast of burden in desert countries both in Africa and Asia. It is peculiarly adapted for a life in the desert in the formation of its feet, enabling it to travel easily on soft sand, in its ability to close its nostrils to exclude the driving sand during sandstorms, in the possession of a reservoir of nourishment contained in its hump, and in a specialised form of stomach in which a store of water can be carried. This useful beast was undoubtedly one of the earliest animals to be domesticated. References to it in the Old Testament are many. The patriarch Job possessed six thousand, and camels formed part of the present which Pharaoh gave to Abraham.

There are several breeds or varieties of the one humped camel, such as the baggage camel, a sturdy beast capable of carrying heavy loads, and the long-legged and swift-riding camel or dromedary.

The two-humped or Bactrian camel is to be found in the desert regions of Central Asia, between Afghanistan and Turkistan, and in China and Southern Siberia. It is distinguished from the Arabian camel by the presence of two humps, and by its stouter and more clumsy build and shorter legs. It is adapted for carrying heavy loads in rocky country with precipitous ascents. It is more thickly covered with hair to adapt it to a colder climate.

In the Yarkand regions there are many wild Bactrian camels, but there is little doubt that these are descendants of domestic animals that have escaped.

There is no doubt that both the llama and the alpaca are descendants of the wild guanaco, an animal that inhabits the countries from Ecuador and Peru to the plains of Patagonia. Its domestication by the Peruvians extends back to a very remote period, and before the introduction of horses and mules the llama was an indispensable possession to its owners as a beast of burden, as well as for food and clothing Prior to the Spanish Conquest these animals were kept in enormous numbers, the males being used as beasts of burden, the females being kept for milk and as providers of flesh.

E N A

CARAVAN OF BACTRIAN CAMELS ON ITS WAY THROUGH TURKESTAN

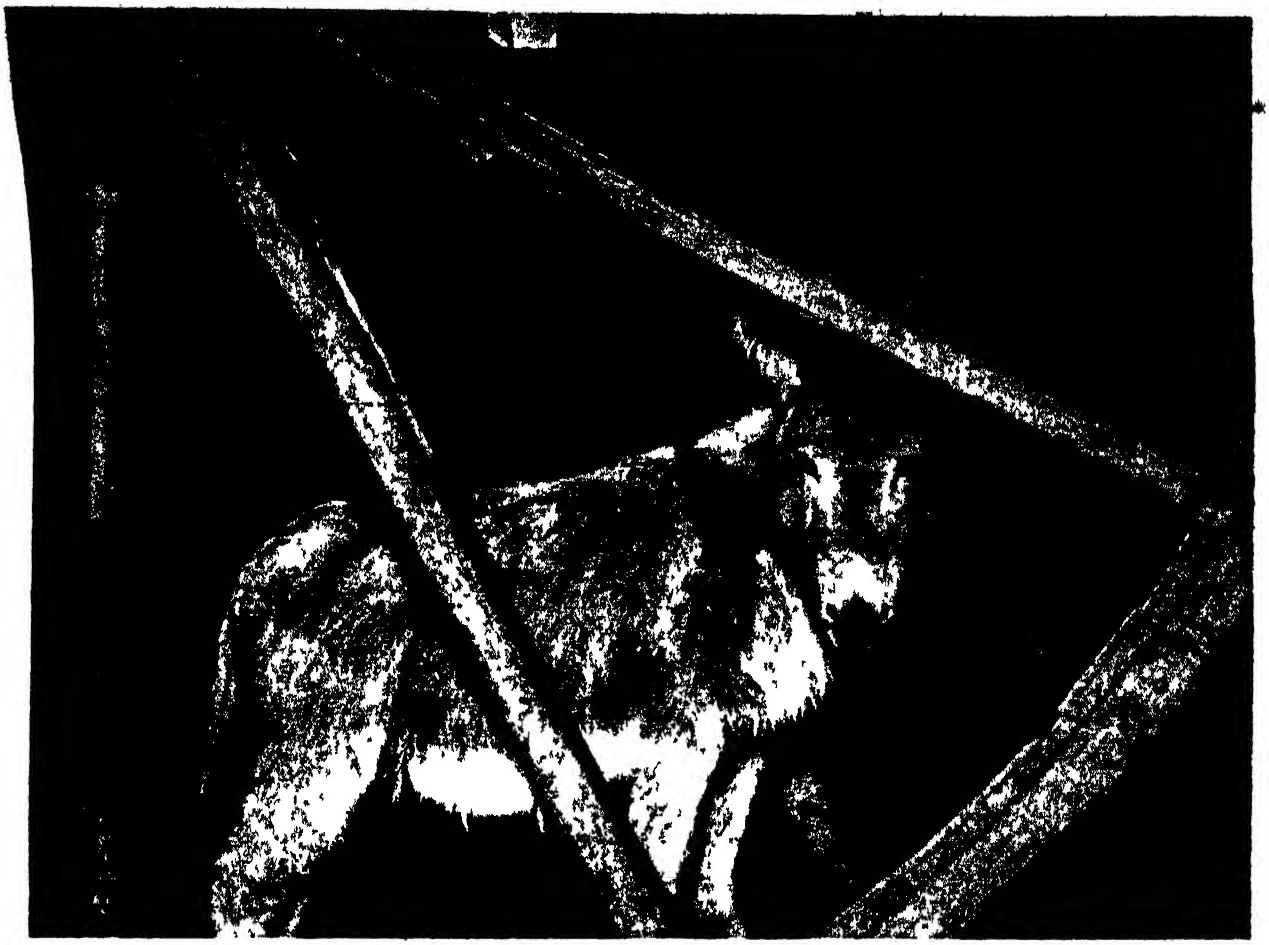
Central Asia is the home of the Bactrian camel, which has two humps It is specially adapted for work in rocky and mountainous country and is not so good on sand as its one-humped relation, the Arabian camel. The hair is long and the legs short, while the whole build is heavier and more clumsy. Of the animals that man has trained for his service the camel takes a high place, for it has served the trade routes under conditions in which no other creature could possibly have survived for centuries.

E N A

McLeish

EGYPTIAN CAMELS AS THEY HAVE WORKED FOR CENTURIES

Despite the influence of Western ideas, the agricultural methods of some parts of Egypt are still much what they were in Bible times. Here (top) is a mixed team of camel and ox working a primitive looking chaff cutter. This mixing of teams for cultivation is still quite common, and it is interesting to recall the old Commandment in Deuteronomy: "Thou shalt not plough with an ox and an ass together." In this case, of ox and camel, the division of labour is evidently fairer than that. Below is a yoke of camels ploughing by the Nile



DONKEY THAT HAS LEARNED A SPECIAL SERVICE FOR ITS MASTERS

Animals have long been used the world over for drawing water, but this form of pump is rather unusual in England, in fact almost unique. It consists of a great treadmill made entirely—treads, and spokes and spindle—from the solid oak. The quality of the workmanship will be understood when it is known that the wheel was made about 1640. The donkey is trained to go into the wheel and walk, turning the whole contrivance as it goes. A farm at Kenworth, near Dunstable, is the scene of this remarkable labour on the part of an animal

The alpaca was bred solely for its wool, which is of excellent quality and considerable length. It is kept in large herds in Bolivia and Southern Peru, and is regularly sheared.

There are very many different breeds of domesticated swine, but their origin is shrouded in obscurity. Doubtless they are partly descended from the European wild boar, but some of the Eastern breeds are quite likely to have been derived from the Indian wild pig, and there is no evidence that they are not descended from others of the numerous wild species still existing. That the domestication of swine is of great antiquity is proved by remains found on the sites of the prehistoric lake-dwellings of Switzerland.

In prehistoric times, when the mammoth and the woolly rhinoceros roamed over Great Britain and the continent of Europe, primitive man hunted wild horses for their flesh, and subsequently domesticated them. Some of these men of the Stone Age left in the caves which they occupied crude sketches of these horses, which [illegible] to have been not unlike the wild horses or tarpans which exist to the present day in Mongolia, though they have long since become extinct in all but a small area of their former range.

Whether all of the present-day breeds of horses are derived from one and the same wild species is uncertain. The swift and elegant Arab horse is so unlike the heavy cart horse that it may perhaps have sprung from an ancestor of a very different race, but we know that remarkable variations can occur under domestication. When we compare the whippet dog with the St. Bernard we see little resemblance between the two, but we know them to have been derived from the same ancestor.

Herds of wild horses exist to-day in America and in Australia, but these are the descendants of domesticated animals that have escaped and reverted to the wild state. The ease with which they are captured and broken to man's service shows that the original wild horse presented no great difficulty in the matter of domestication.

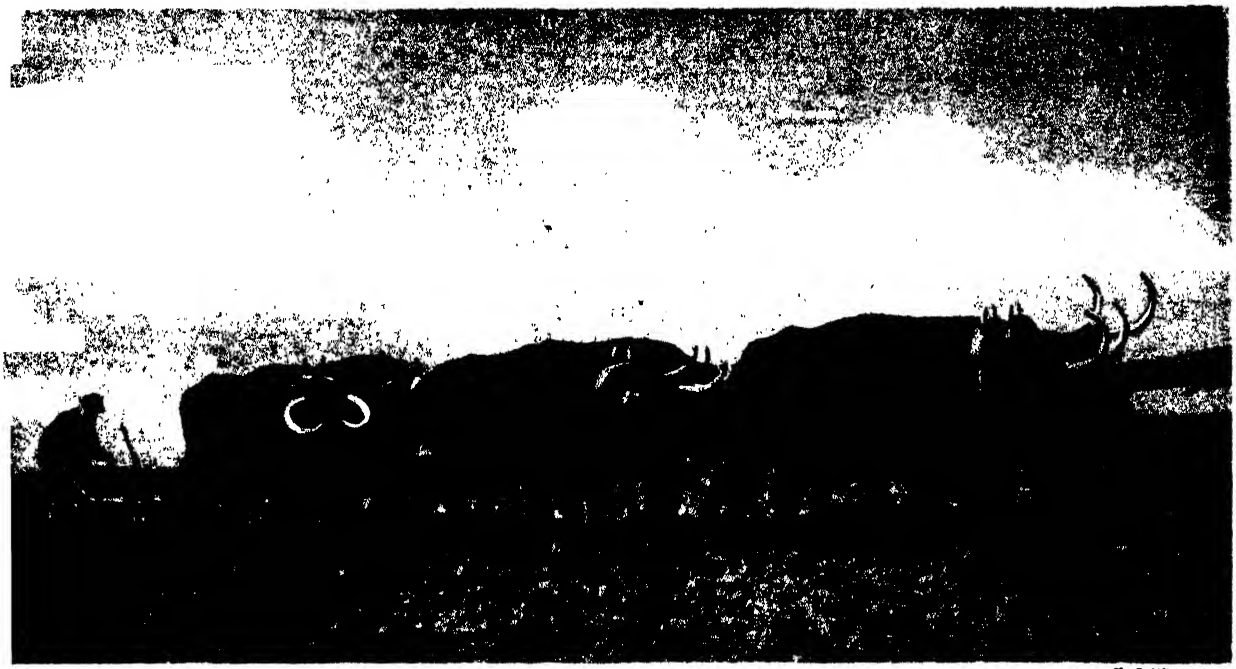
It is probable that the ass was first domesticated by the ancient Egyptians, who knew it long before

Realistic Travels

Ewing Galloway

BEASTS OF BURDEN IN CENTRAL ASIA AND SOUTH AMERICA

In Western Tibet, where the lower photograph was taken, the yak is the chief means of transport. A native of the country, it can survive hardships and conditions which might kill other animals With only a little hay to eat it can carry a good load. The giddy mountain paths that thread the Andes necessitate the use of pack animals and, here again, the animals native to the country have been pressed into service. The photograph (top) shows a llama pack train outside La Paz, the commercial capital of Bolivia.



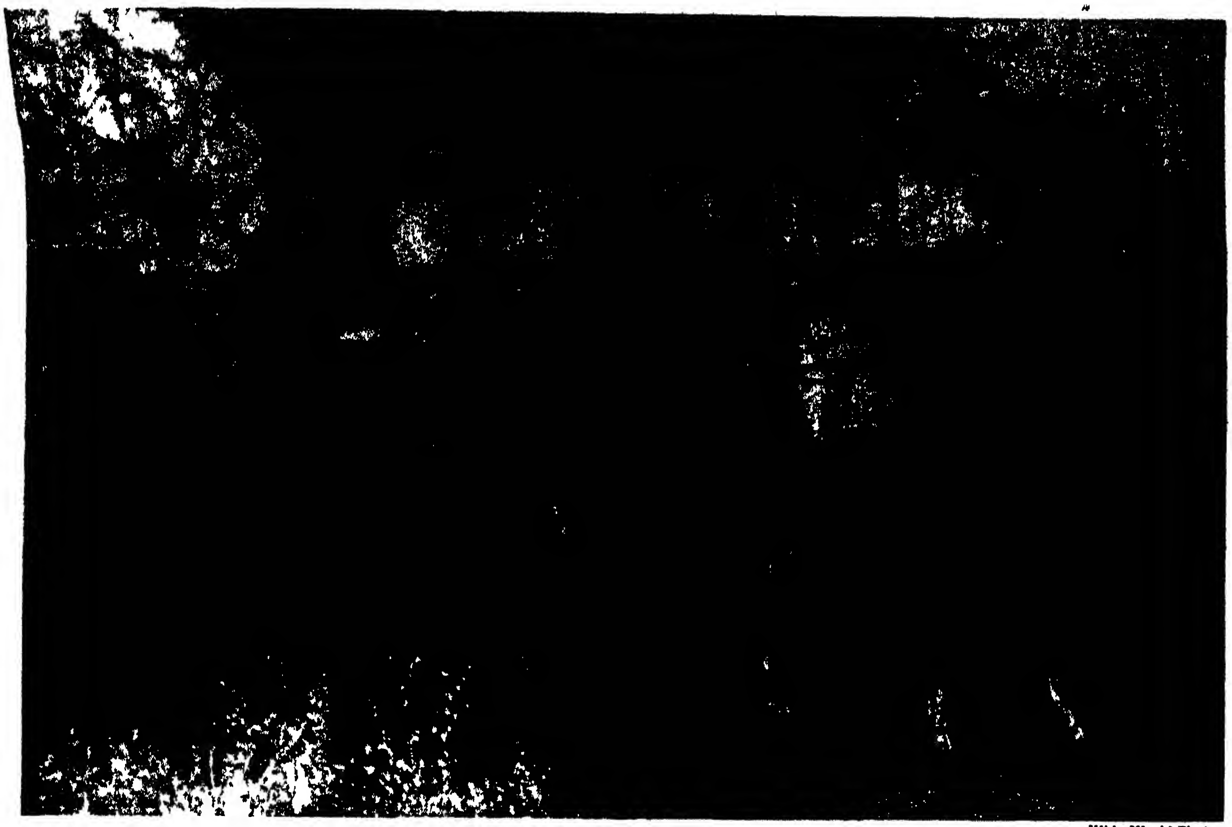
K. G. Willghan

HERE OXEN ARE STILL BEING USED FOR THE PLOUGH IN ENGLAND

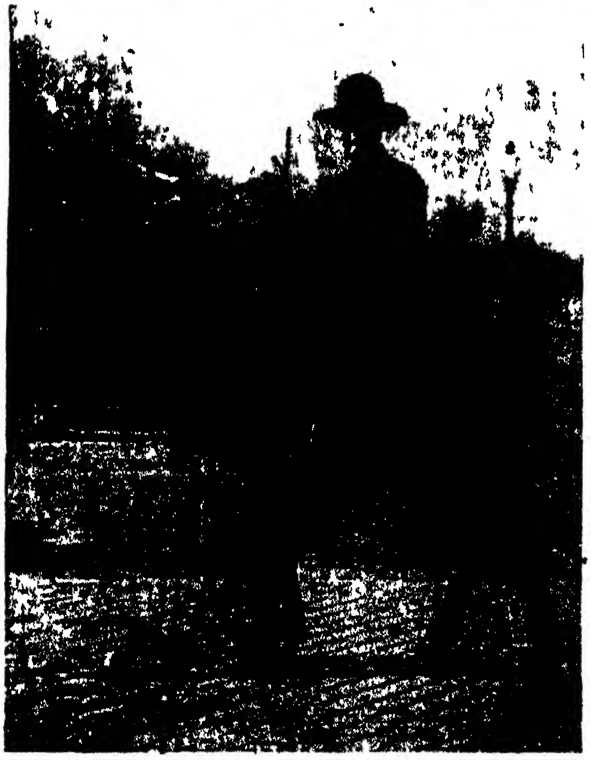
Oxen for agricultural labour, while still common on the Continent, are almost unheard of in England. Yet both these photographs were taken in England. The lower one shows a team drawing a hay cart on the estate of Earl Bathurst, while above is a ploughman of Sussex ploughing with three pairs of oxen on the South Downs. It is probably the last team for the purpose left in the country, and the scene might well have been taken from another century.

OXEN IN INDIA AND SOME OF THE WORK THEY DO

Nicely balanced as they are, these great baulks of timber (bottom) seem a tremendous load both for cart and animal as they trundle through one of Bombay's broad streets. The ox is the principal beast of burden in India and is not only used for such menial labour as this. It takes its part on state occasions, as we see in the upper photograph of a zenana or harem carriage belonging to a maharaja. The oxen are humped, and it is to be noticed that the rich draperies that cover them are shaped to fit the humps.



Wide World Photos



HARNESSING THE WAPITI

Of the red deer family the wapiti is the largest and finest. Formerly common in Montana it is now mostly confined to reservations. In the United States it is often confusingly called the elk. An attempt was made in Chicago to start a fashion for "elk" driving (top).

they knew the horse, for it was then as now, a common wild animal in the desert regions of North-Eastern Africa. As a domestic animal, useful both as a draught animal and for its milk, the ass has been introduced into practically every part of the world. In England it was known in the reign of Ethelred, but it did not become common until after the reign of Queen Elizabeth, having probably become extinct and been re-introduced in the meantime.

In most parts of Europe the ass has greatly deteriorated in size under domestication, due to poor feeding, but in the south some very fine breeds have been produced, while in the United States a breed of very large proportions has been established, some specimens reaching a height of sixteen hands.

Of all animals, the elephant is the most easily tamed and trained to perform useful service to man. From time immemorial the Asiatic elephant has been trained to work, the natives of India and Burma showing great aptitude for the handling of these and other wild animals; and it must be remembered that the elephants in captivity are almost all wild-caught animals, not those bred from captive animals, for the elephant does not readily breed in captivity. It is not encouraged to do so, for since these animals are so easily tamed from the wild state when captured as adult or semi-adult animals, it would not pay to breed them in captivity. A few months after capture the elephant is sufficiently docile to be worked.

The natives of Africa have shown little aptitude for the handling of wild animals, which may account

for the fact that the African elephant has rarely been tamed. It is probably less suited to work than its Eastern relative, but it has been proved to be quite capable of domestication.

There is much evidence to show that the dog was one of the earliest animals to be domesticated. Men of the Iron and Bronze Ages possessed several distinct breeds, and Darwin remarks that " At a period between four and five thousand years ago various breeds, namely pariah dogs, greyhounds, common hounds, mastiffs, house-dogs, lapdogs and turnspits existed, more or less closely resembling our present breeds." It is not surprising, therefore, that the species from which the domestic dog has descended should remain a matter of conjecture. We should incline to

F. W. Bond

MIGHTY ELEPHANT USED IN ENGLAND FOR GIANT'S TASKS

Log lifting by elephants is familiar enough in the teak yards of Malaya, but seldom seen in England Our upper photograph shows a Zoo elephant coping with a large piece of tree trunk while the keeper, mounted on the animal, is directing operations Below is a pair of circus elephants engaged in cultivating a field on the farm belonging to the proprietor of the circus. He makes his elephants earn part of their keep by a little land work on his Surrey estate during the winter

Keystone

OSTRICH, GREATEST OF BIRDS, BROUGHT INTO MAN'S SERVICE IN THE REALMS OF PLEASURE

While much horrible and revolting cruelty has been practised on birds whose feathers are desirable as ornaments, the ostrich is docked of its feathers without pain or fear. Here (left) is a scene on an ostrich farm at South Pasadena, in California, where a considerable number of birds are reared. The operation of plucking is in progress. The bird is hoodwinked at the start so that it shall not be restive, and the feathers are cut off at the quills, not pulled out, which would involve pain and injury. In Czecho Slovakia the ostrich has been pressed into the service of amusement by the organization of ostrich racing (right). This is the winning bird with its jockey at an ostrich race-meeting.

TAKING PART IN THE ATTRACTIONS OF THE ZOO: OSTRICH AND ITS CART

All the fun at the Zoo is not kept behind the bars. Various animals have been taught to play their part in aiding in the upkeep of the Zoological Gardens by earning some extra money as providers of "rides" for the children. The ostrich makes a novel steed to draw the children's chariot and is one of the most popular of the various attractions of that sort provided by the Gardens. Incidentally, the ostrich is one of the swiftest runners of the animal world, but at the Zoo its pace is stately.

the belief that the common wolf of Europe was the ancestor of the dog, and that the extreme variation of types that has long existed is the result of selection during a long period, but since many of the wild species of wolves and dogs will interbreed and produce fertile offspring, the fact that domestic dogs of various breeds are fertile when crossed is no infallible proof that one wild species alone was their ancestor.

The domestic cat was kept by the ancient Egyptians, and it seems probable that it was derived from the Caffre cat, the common wild cat of Egypt, but whether the present-day domestic cats of Europe, which have been distributed to all parts of the world, are all descended from the Caffre or Egyptian cat is open to question. There seem to be two distinct types of domestic cat, one of which closely resembles both the Egyptian cat and the European wild cat, and doubtless, it owes its descent to both of these species, but the other type resembles no wild species existing at the present day, and may be the descendant of some extinct species. The so-called Persian, Siamese, Russian and Manx cats are merely varieties which, so far as we know, have been derived from the same stock as the others, but have been specialised by careful breeding and selection on the part of man.

Among rodents, there are several that have been domesticated; the brown rat and the house mouse have proved themselves capable of existing in a tamed state as readily as in the wild, and have produced many colour varieties, but these two species have been kept rather as pets than as utility animals.

The rabbit has for long been domesticated for food and its fur, while the domestication of the cavy, or guinea-pig, probably dates back to the time of the Incas of Peru. It was introduced into Europe by the Dutch during the sixteenth century, shortly after the discovery of America.

The ferret is merely a domesticated polecat, an animal that is found throughout the greater part of Europe, but is now rare in most parts of the British Isles. It is a bloodthirsty animal, killing and devouring any creature that it can overcome. Very long ago it was found that the young could be tamed, and, when adult, would breed in captivity, and that the tamed animals were extremely useful for bolting rabbits and rats from their burrows. Precisely

WORLD FAMOUS ST BERNARD DOGS AND INDIAN HUNTING LEOPARD

E. N. A.

For generations the monks of the hospice at the head of the Great St. Bernard Pass have trained the famous breed of mastiff (bottom), called the St. Bernard, to find travellers lost in the snow. The St. Bernard is the largest domesticated dog known in Great Britain and is possessed of remarkably keen intelligence. Among its special characteristics are the very large feet. In India the cheetah has long been trained for hunting, and is known as the hunting leopard. This one is being driven to a " meet."

Keystone

FISHERMEN OF JAPAN WHO USE LIVE CORMORANTS INSTEAD OF HOOKS AND BAIT

A most ingenious method of catching fish is practised in Japan. The fishermen set forth in their boat (top), which has an iron basket in the bows. The fishing grounds are reached at night and a fire is lighted in the basket. This attracts the fish and the cormorants dive into the water and seize them. The birds are attached by lines to the boat and are hauled in and made to give up the fish. Thus there is no question of waiting for a bite. The lower photograph shows some fishermen with the birds.

E.N.A

ZEBRAS WORKING IN KENYA COLONY

The fact that the handsome Grevy's zebra of East Africa is immune from the attacks of the dreaded tsetse fly has recommended it to colonists as a substitute for the mule. But though easily broken to harness the zebra has far less power of endurance than the mule and is much more liable to panic. Here we have a team in Kenya where two zebras are harnessed in between pairs of mules.

when the polecat was first domesticated, and thus became the ferret is not known, but we know that it was familiar to the Romans, and that it was employed for rabbit catching in Pliny's time.

Certain of the birds were domesticated by man at a very early period, one of the earliest probably being the common fowl. Domestic fowls have all been derived from the wild red jungle-fowl of India and Burma, and it is probable that the latter country was the one in which the domestication of the species commenced, at a date somewhere around 1400 B.C.

The wild duck, or mallard, was also early domesticated, and from it have descended all of the present-day breeds of domestic ducks, if we except the muscovy, which hails from South America.

Domestic geese have been derived from the grey lag goose, a widely-distributed European species that at one time bred freely in the fen-country of England, though it has long since ceased to do so. It still breeds sparingly in Scotland and in the Hebrides. Its domestication probably dates back to a very early period.

The domestic turkey is derived from a wild species inhabiting Mexico, and its domestication probably dates back to an early period, though its introduction into Europe was accomplished by the Spaniards about 1518, on the discovery of Mexico.

The tame guinea-fowl is descended from a wild species inhabiting West Africa.

THE latest bird to be tamed for utilitarian purposes is the ostrich, the demand for whose plumes led to its being farmed in South Africa and other countries, where it has been bred very extensively for feather production and thus saved from extermination.

Other birds have been tamed for the service of man, such as the falcon for hunting and the cormorant for fishing, but these have now been bred in captivity from generation to generation and thus become thoroughly domesticated.

We have space only to mention certain of the insects that man has found serviceable to his well-being, and brought under his control. The honey bee, which is supposed to be of Asiatic origin, has for ages past been extensively cultivated, and has formed a great industry, while the silkworm is of no less importance. The silk industry is of great antiquity, and originated in China, where it was carefully guarded for many centuries before it reached Japan in the third century. There it grew into a great industry, a knowledge of which eventually spread westward to India and beyond to Europe.

The cochineal insect, a little creature which feeds upon various species of cactus, is a native of Mexico, where its valuable dyeing properties were known long before the arrival of the Spaniards in 1518. These introduced it to Europe. It has since been cultivated in Algiers, the South of Spain, and the Canary Islands.

Closely allied to the cochineal is the lac insect, which has also proved of great service to man by the resinous incrustation it forms on branches of trees, which is of considerable value, both for dyeing purposes and as shellac. The insect is carefully cultivated in the East Indies, Bengal, Pegu, Siam and Assam.

It must be borne in mind that for successful domestication animals must possess certain qualities. They must be useful as food, as fur-bearers, as draught animals, or for some other definite utility purpose, or their culture will not be profitable. It is essential, also, that they be adapted for a captive life, that they breed readily in captivity, and their young mature rapidly. It would appear as if there were few animals left that possess these qualifications, or, at any rate, possess them to so great an extent as those that have already been domesticated. To take the case of the zebra, for instance. There is no difficulty in breaking-in zebras to harness, but when this is done, they have less stamina, and are far more subject to panic than horses. The only object there may be in taming the handsome Grevy's zebra of East Africa is that it is immune to the attacks of the tsetse fly, and for this reason its adoption may be worth while. The taming and breeding of fur-bearing animals, such as silver foxes and skunks, is already practised, and others may perhaps be domesticated to meet the world's demand for furs.

Chapter XXXIX

The Mystery of the Jumping Bean

By John J. Ward

Author of "Insect Biographies With Pen and Camera"

THE observing naturalist not infrequently discovers instances where Nature has, as it were, re-used an ingenious idea in some entirely different connexion, merely altering details, but, nevertheless, revealing the plan of the same architect. Such instances offer, perhaps, the greatest possible proof that in Nature's creations there is certainly mind as well as matter.

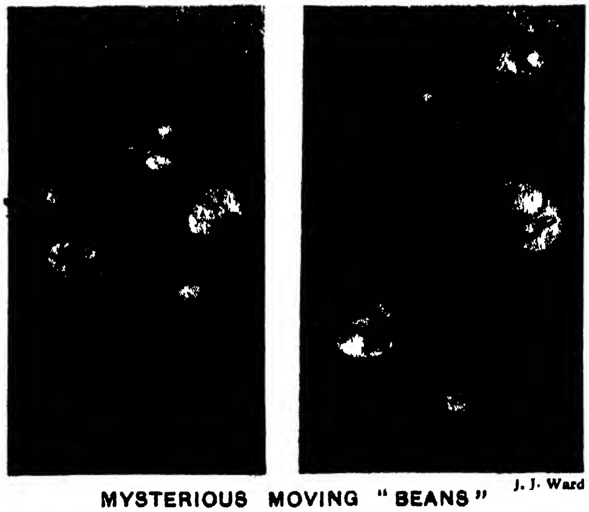
There is, for example, the jumping bean of Mexico, and the much less familiar jumping disc of the sycamore leaf of the British Isles. Here we have parts of two entirely unrelated members of the plant world animated by caterpillars also far removed in relationship, the former belonging to the order Lepidoptera (butterflies and moths), and the latter to the order Hymenoptera (ants, bees, wasps, saw-flies, and so on), yet in each case the principle of their movement and the ground plan of their scheme are almost identical.

The so-called jumping bean is not really a bean at all, but one of three divisions of the fruit of a large species of spurge of the genus Sebastiana, a native plant of Mexico. British spurges of the genus Euphorbia are familiar in most country gardens as weeds, the stems of which when broken yield a milky juice—a rustic cure for warts. If we examine the yellowish-green fruits of these plants with a magnifying lens, we find they consist of three "beans" just like those of the Mexican species, but on a miniature scale. None of them, however, is able to jump. How comes it then that the American species should possess this extraordinary attribute? This is one of the mysteries with which the enquiring mind of the scientific investigator of Nature is continually being confronted.

It is not all the "beans" of the Mexican spurge that will jump, only an occasional one; one that has received an egg from a moth (*Carpocapsa saltitans*) that is nearly related to our British codling moth (*Carpocapsa pomonana*), whose larvae are the cause of worm-eaten apples of the codling species. The egg is placed on the "bean" at an early stage of the fruit's growth, and the caterpillar hatching from it bores its way inside, consuming the developing tissues but avoiding the outer covering skin, which hardens as the fruit matures. When the ripened seeds are ready to fall the caterpillar is full-fed, and it is then securely enclosed in its curious domicile. It is then ready to change to the pupa stage, but does not immediately pupate; indeed, not for several months to come, for it may need to jump on many occasions during that period, and after becoming a chrysalis its jumping powers cease.

Why does the caterpillar within the seed need to jump? The Sebastiana spurge grows in warm, marshy areas, the temperature of which during the growing season exactly meets the needs of the moth larva. When, however, the dry season begins, and the seeds fall in exposed places, there is always the danger of the scorching rays from the sun; hence it is very necessary for the caterpillar to be able to move its residence to more sheltered situations. It is, therefore, always ready to decamp to a more shady area, and should the sunlight eventually reach that place, it once again begins to travel. As the moth necessarily has to appear to deposit its eggs at that season when the young fruits are growing, the caterpillar, to avoid this danger of the heat, has to keep active within its covering shell for seven or eight months. In the early part of the year it changes to the pupa stage, but before doing so it perforates with its mandibles in the roof of its case a circular lid that can easily be pushed aside when it, as a perfect moth, is ready to emerge.

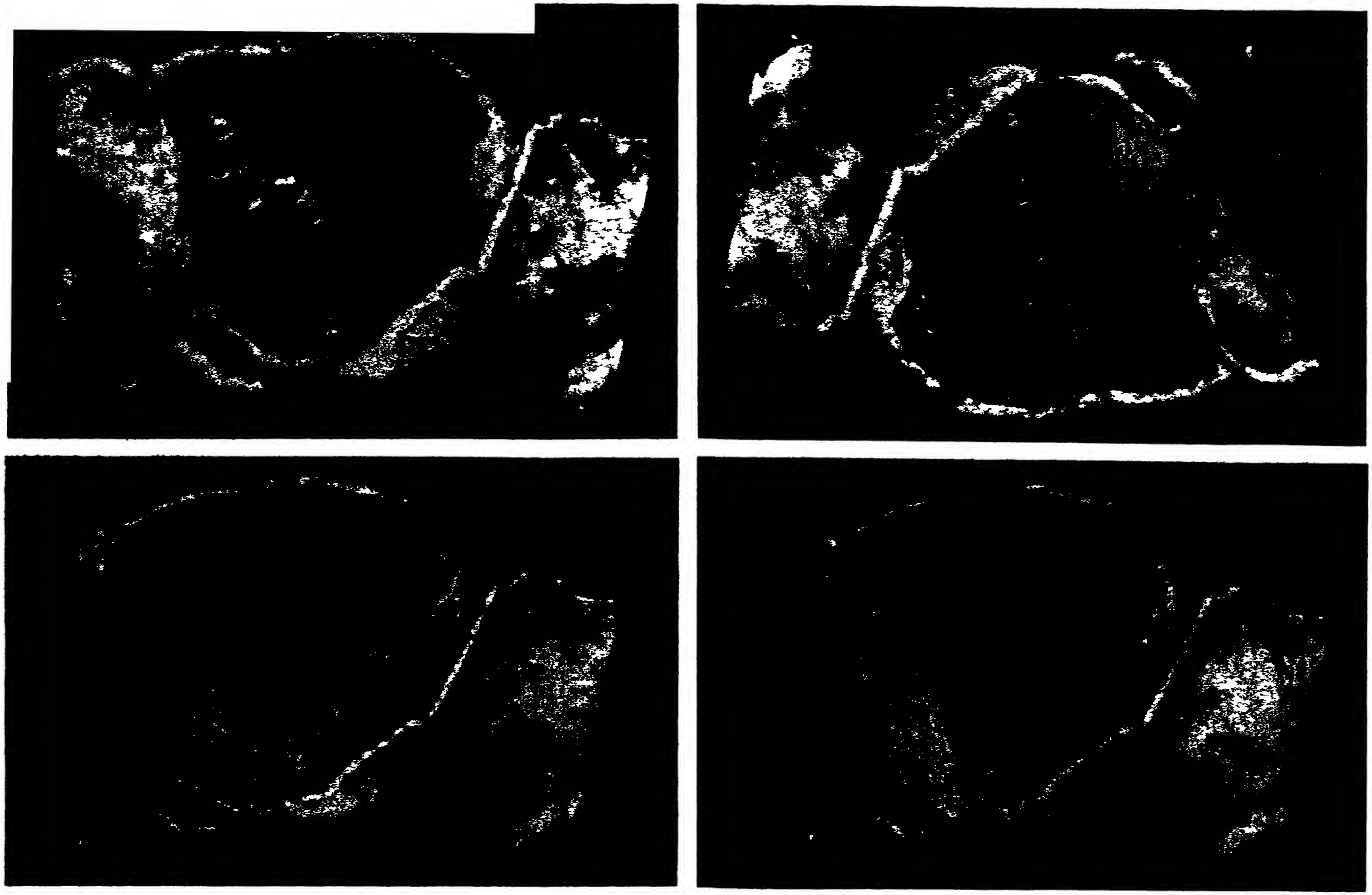
Having now learned what the "bean" is, the nature of the creature that controls it, and the stimulus that excites it to activity, there remains for explanation the mystery of its remarkable form of locomotion. For remarkable is the only word that describes this ingenious business which is so simple—when we understand it. We have but to think for a moment to realize that the caterpillar in the closed case is apparently moving in a manner that contradicts the laws of mechanics. It is obvious that the forward thrust of the larva enclosed in its shell would be counteracted by the push backwards of its own weight, yet it continues to travel with regular little jerks, and, still more wonderful, occasionally gives distinct hops, even lifting itself and its case well clear of the surface on which it happens to be resting.



J. J. Ward

MYSTERIOUS MOVING "BEANS"

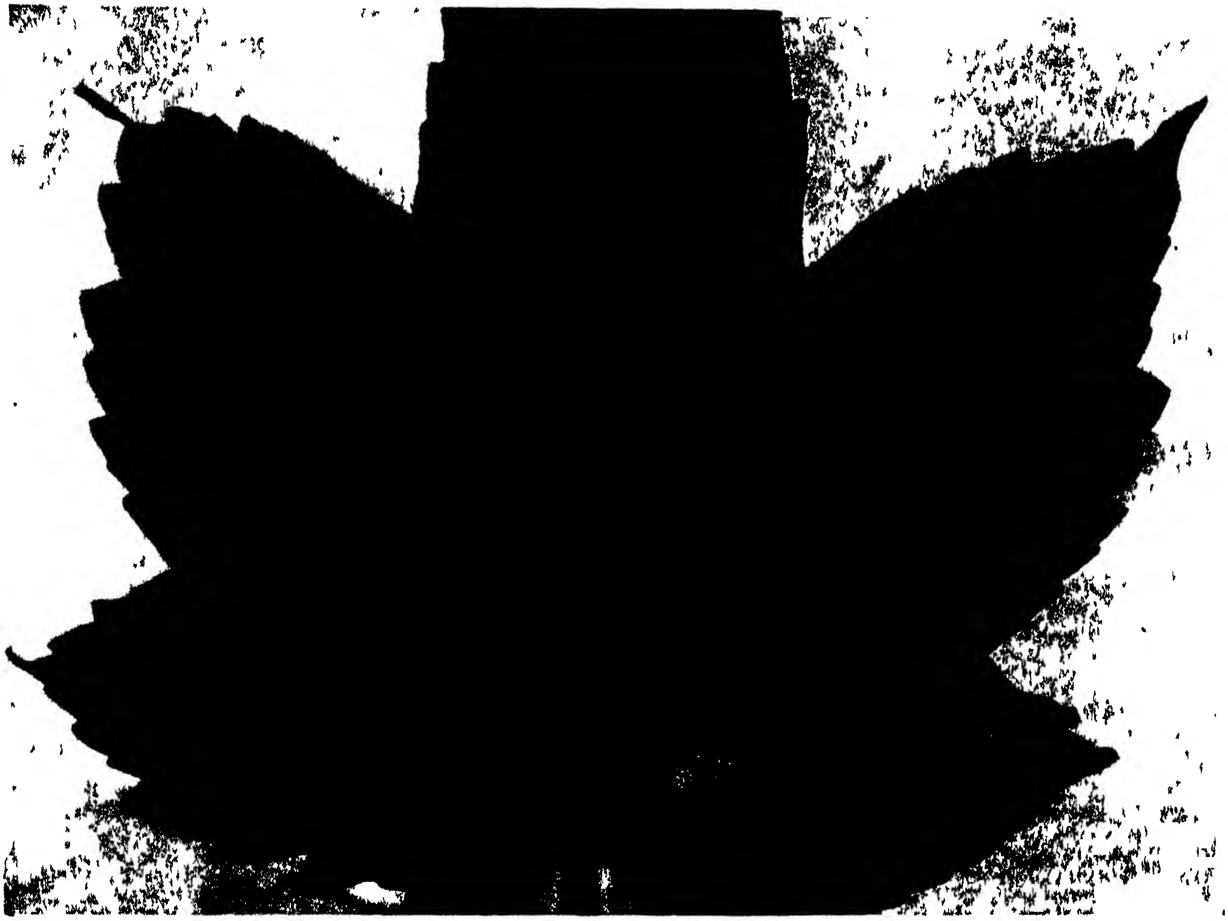
These photographs are of the fruit of a plant which grows in Mexico. On the left we see the fruit resting on a cool surface; on the right, after heat has been applied, causing the "beans" to move. The mystery of the movement was for long unexplained



J. J. Ward

WHY THE "BEAN" JUMPS: A PUZZLE OF NATURE EXPLAINED BY THE CAMERA

This series of photographs shows what happened when one of the " jumping beans " was split open, revealing the caterpillar of a moth. In the top left-hand photograph the caterpillar is beginning to repair the damage done to its home by the splitting of the " bean." The " bean " affords the caterpillar shelter from the heat of the sun, and if it falls in a place too exposed, the inmate must move to a sheltered spot. This it does by striking its head against the wall of its abode and using a silk netting as an elastic propellant, thus causing the bean to jerk over. The caterpillar (top right) spins threads across one half of the shell. Next (bottom left) it spins across the other half till, in less than an hour (bottom right), the silk netting is complete.



J J Ward

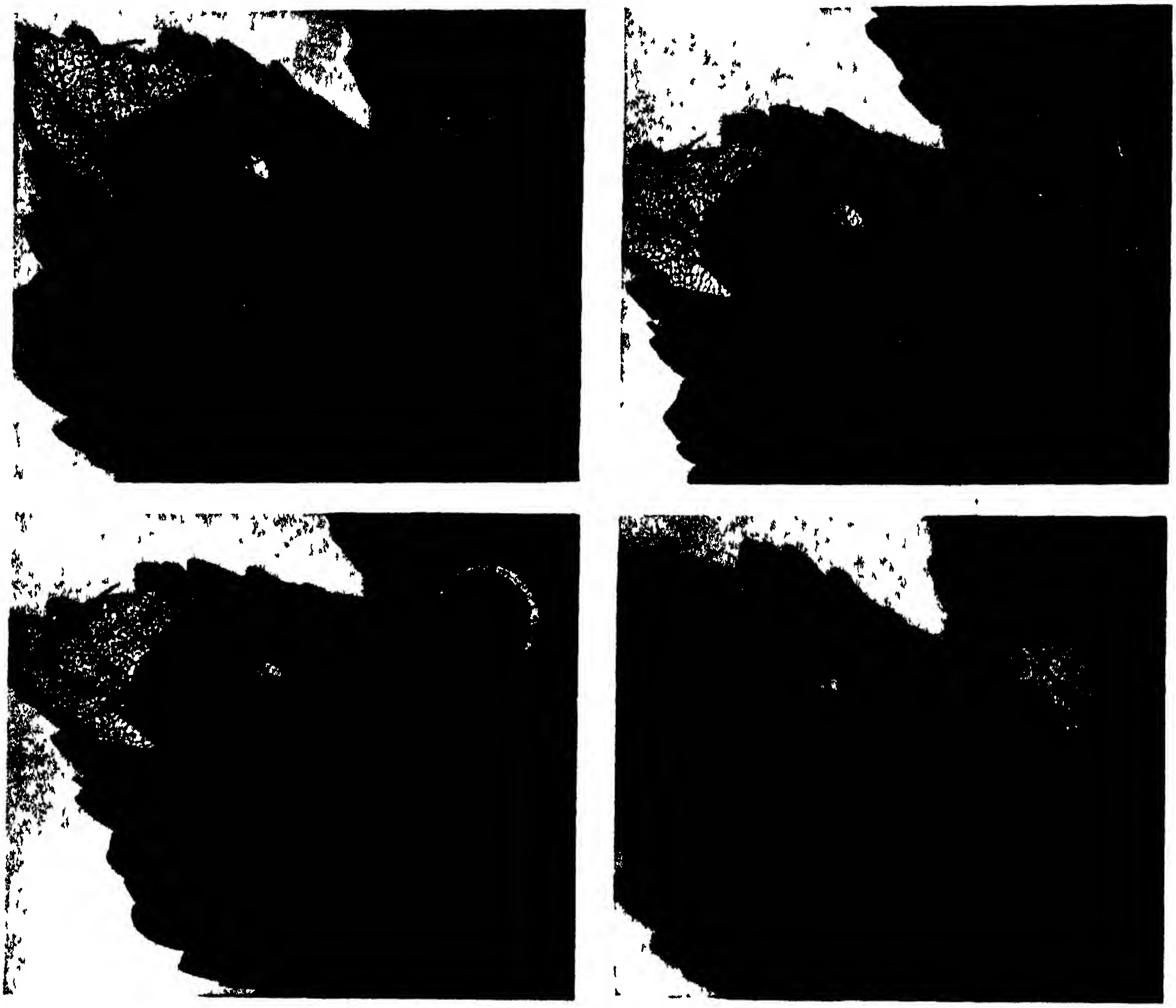
GRUB OF A SAW-FLY FEEDING BUSILY ON A SYCAMORE LEAF

The saw-fly is so called because it possesses an ovipositor—the organ that deposits the eggs—formed like a pair of saws which cut into the tips of leaves. The fly lays its eggs in the point of a lobe, from one to three eggs to each leaf, and the grub hatches out between the upper and lower skins of the leaf. For ten days or so it is hard at work feeding, and is then ready to begin its remarkable disk-cutting operation. The leaf by this time has suffered considerably

Many unconvincing hypotheses have been advanced by scientific and unscientific people to provide an explanation of these extraordinary movements, such as the fanciful idea that they are due to the expansion of the air within the "bean" when heat is applied; or that they are produced by the alteration in the tension of particles of the fruit coat as it becomes warmed; but experiments readily show that such suggestions are no solution of the problem. Let us therefore investigate the matter more closely with no other evidence than that which the "bean" itself provides, some important details of which have hitherto been overlooked.

On cutting open a fruit-segment containing a larva, the latter (as the photographs clearly show) at once proceeds to repair the damage by means of silken threads, and in about one hour it has woven a loose covering on the exposed side. On the application of warmth the caterpillar when so covered can move its abode just as readily as when it is properly sealed. Obviously expansion of air and alteration of tension in the fruit particles entirely fail as solutions when the larva is covered with an open network of threads. If, however, we apply the stimulus of heat when the caterpillar has spun only a few threads, then we can see what happens inside, and so get its secret revealed.

When the larva feels the objectionable heat it grips firmly with its tail claspers the silken lining of its shell and aims consecutive blows with its head at a given spot on the part above it, apparently with increasing vigour at each blow, until the "bean" jerks along, or rolls over. There is more in this action than at first meets the eye, for if we observe more closely we see that with each thrust when making its aims the larva secretes from a gland beneath its head a viscid thread, against which it throws the weight and pull of its body. Thread after thread is projected until, in connexion with the weaker or stronger pull of the threads to which it is attached at its tail-end, the correct propulsive impetus is obtained to jerk forward, lift, or overturn the seed-capsule. It is really a catapult action, the silk providing the "elastic," the walls of its dwelling the "forked twig," and the caterpillar itself the "stone."



J. J. Ward

"JUMPING DISK" BEING CUT FROM THE LIVING LEAF

When the saw-fly grub has taken in its full supply of food it removes to the far corner of its feeding area and proceeds to bite a circular piece only of the upper skin (top left) It then makes a kind of floor for this leaf disk by emitting a gum-like substance which hardens into an elastic and semi-transparent plate. This lower surface is neatly joined to the leaf disk, and covered inside with network of silk. When all is ready the grub jerks itself about (bottom left) until the disk is torn free (bottom right).

The larva is not, however, hurled helplessly about the interior of its case; indeed, it is so well able to control its threads that it can obtain propulsive power and apply its brakes with astonishing precision. Moreover, if it finds that its movements are not directing it to a cooler spot, by changing its "rudder" attachment and aiming its blows at another part of its case, it can change its course.

Now let us turn to the much less known jumping novelty which the leaves of a sycamore tree will sometimes provide. Here we have a tiny saw-fly (*Phyllotoma aceris*) to deal with, one scarcely half the size of a house-fly, and called "saw-fly" because at its tail-end it is provided with an ovipositor consisting of a pair of saws for cutting incisions in the leaf tips to deposit its eggs. Sometimes only one egg is placed on a leaf, and at other times two or three. When the egg hatches the grub finds itself under cover between the upper and lower cuticles of the leaf; and that is its golden rule in life—that it must never expose itself to the open air. Outside its dangers are innumerable from parasitic foes. The tiny grub proceeds to mine its way between the upper and lower skins of the leaf, eating out the green material for nine or ten days, at the end of which time it is full-fed The lobe of the leaf in which it has been feeding then bears a bleached and blistered appearance, but the grub still remains between the leaf skins, for it now finds itself up against a difficult problem. It has to descend from the sycamore leaf to the ground for the next stage of its development, and without exposing itself to the open air. This apparently impossible task it immediately proceeds to put into action

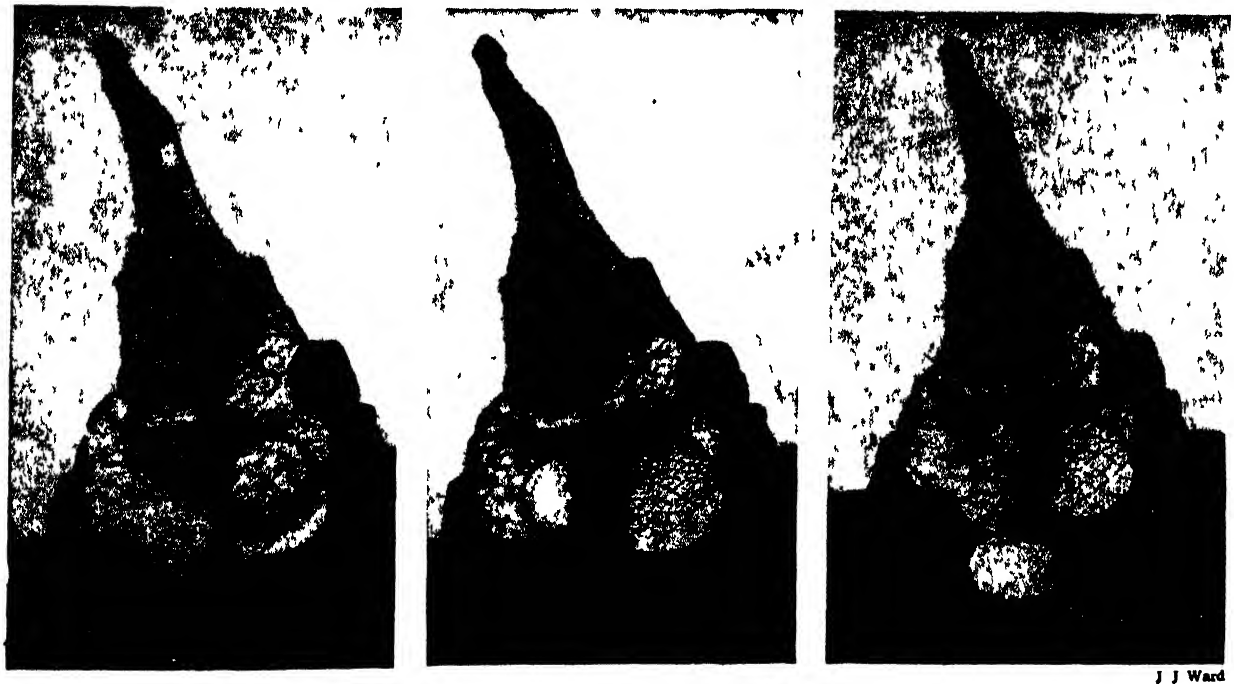
Removing to the most remote corner of its feeding area it pivots, in some mysterious manner, round on what may be termed its own centre, for it completes a circle the diameter of its own length, keeping its mandibles upturned and biting a series of slits in the upper cuticle of the leaf as it moves round. Just how it contrives to turn completely round and retain its centre, is a secret which only the grub itself can reveal. Notwithstanding the difficulties, a neatly perforated circle of considerable accuracy is completed.

The grub then proceeds to turn its attention to the under side of the disk, spending several hours in constructing for it a lower floor, entirely avoiding the under skin of the leaf. This floor is a somewhat remarkable structure, being semi-transparent and formed of a kind of liquid gum which hardens and forms a plate with elastic properties. It is neatly joined to the edges of the perforated disk, the whole then forming a weatherproof shelter in which the grub has to spend some ten or eleven months of its life before it can emerge as a winged fly

By the time that the grub's "saloon car" is ready for its travels, the air has penetrated beneath the perforations and the disk has a tendency to break away at its edges as it becomes dry, but the centre of the lower floor retains a hold. While so held the grub cannot escape, and, like the caterpillar of the jumping bean, it greatly resents powerful rays of sunlight, which cause it to kick out vigorously inside its disk. Its kicking is quite audible as a clicking noise, and if the tip of the leaf is watched, the disk is seen to respond suddenly to one of the grub's more determined efforts and become detached from the leaf, eventally falling to the ground. There it continues to travel with irregular jerks until a cool and sheltered spot is reached.

The semi-transparent side of the disk allows us to see just what movements take place inside while it is in locomotion. The grub holds firmly by its mandibles to the inner edge and then swings its tail-end from side to side with increasing force, which causes the disk to rock until it jerks along, or it may turn completely over. Here we have quite a contrary behaviour to that of the jumping bean caterpillar, which held by its tail-end and struck out with its head. Since this grub is also able to travel while in a closed chamber, we may again suspect that silken threads play a part in its movements. A careful microscopic examination of the elastic floor entirely confirmed that suspicion, for I found that its inner side was lined with an irregular network of delicate threads. Still more interesting was the discovery that the upper side of the disk—the leaf tissue—was lined only with a layer of the gelatinous substance of which the lower floor was built.

At the tail-end of the grub is a pair of claspers which grip the threads on this flexible floor and snatch them aside as the grub swings its body to and fro This action then converts the flexible floor into a veritable spring-board. Now we learn why the grub left the lower skin of the leaf intact. It needed a spring-board for jumping purposes, and the leaf tissue did not provide sufficient elasticity.



J J Ward

DISK DETACHES ITSELF FROM ITS LEAF AND FALLS

The saw-fly grub wants to find a spot on the ground, sheltered and at the right temperature, where it can go through its metamorphosis from grub to fly. When it has made a home for itself, as seen and described in the opposite page, it wriggles until the disk detaches itself and begins to fall (left) It slides down the leaf (centre and right) and eventually falls to the ground There, by means of the elastic threads inside, the grub swings itself to and fro with enough force to move the disk along till it reaches a suitable place.

W Saville Kent

W S. Berridge

GLIDING AND FLYING MAMMALS: PHALANGER AND BAT

Among the numerous kinds of phalanger is the short headed phalanger or flying opossum (bottom) and it, like its kind, makes long gliding leaps from branch to branch or tree to tree The necessary resistance to the air is provided by a double fold of skin which extends outwards from the body to the limbs The spreading of the limbs stretches this membrane for gliding. The bat (top) also has a membrane stretched between its limbs but is a true flyer, flapping the wing up and down and not merely gliding with it stiff and still.

Chapter XL

Four-Footed Creatures that Fly

By C. Tate Regan, F.R.S.

Director, Natural History Museum, London

THERE are perhaps more than a million different kinds of living animals, every one with its own method of finding something to eat and of avoiding being eaten; they have left no source of food untapped and no method of getting it untried, and their devices for deceiving or escaping their enemies are numberless. Flight through the air is an excellent way of baffling a pursuer who cannot fly, and also gives a direct approach to many supplies of food that are otherwise not easily reached.

Flying animals may be broadly divided into those that fly by upward and downward strokes of the wings, carried on by muscular action, such as insects, birds and bats; and those whose flight is merely a prolonged leap, dependent for its extent on the initial impetus and on the size of the wing membranes, such as the various kinds of flying fishes, flying lizards and flying squirrels.

The name Tetrapoda, or four-footed vertebrates, is given by zoologists to the backboned animals other than fishes, which agree in having two pairs of limbs formed on the same fundamental plan, the fore-limb consisting of upper arm, fore-arm, wrist and fingers, and the hind-limb of thigh, shin, ankle, and toes. These animals are primarily terrestrial, with limbs adapted for the support of the body, and for locomotion on land. Some of them, however, have become aquatic, such as the extinct ichthyosaurian reptiles and the whales, and in these the limbs have been transformed into paddles.

Others have developed the power of flight, pterodactyls, birds and bats, and in them the fore-limbs are modified into wings. It is very interesting to compare the skeleton of the wing of a bird with that of a bat, of the paddle of a whale or of the human arm, and to see the underlying similarity of structure in all, the same plan being modified for different purposes in relation to different habits.

SOME arboreal snakes of Borneo have the habit of throwing themselves into the air from trees; keeping the body straight they glide obliquely downwards, drawing in the ventral scales so that the under side of the body is concave, and thus increasing the resistance to the air. The little flying lizards (*Draco*), of which more than a score of species are known from tropical Asia, have the skin on each side of the body extended to form a sheet-like membrane, which is supported by the long and slender ribs, and can be folded back against the sides like an umbrella. This structure is quite unique. These animals live in trees and run along the branches in search of insects with their "wings" folded, and then, spreading them out to their fullest extent, glide obliquely down from bough to bough, or from tree to tree. The above are the only living reptiles that can be designated "flying," but millions of years ago there were others. The Mesozoic, or Secondary Period, is sometimes termed the Age of Reptiles, for in those remote times mammals and birds were an insignificant element of the fauna, and reptiles were dominant. Carnivorous and herbivorous reptiles occupied the land, large marine reptiles played the parts now taken by whales and seals, and flying reptiles winged their way through the air.

The pterodactyls, long since extinct, were reptiles in which, as in the bats, an enormous wing membrane extended from the very long fore-limbs to the ankles; the fifth finger was much elongated and supported the wing membrane, but the other four fingers were short and free, and ended in claws. The breastbone had a small keel for the insertion of the wing muscles, and support to the wings was given by the union of the shoulder-blades with the backbone. The head was long, with pointed bird-like beak.

THE pterodactyls were a large and varied tribe, some with a long tail and others without one, some no bigger than sparrows and others with a wing span of nearly twenty feet. We know nothing of their origin, but from their structure we may infer their derivation from arboreal gliding ancestors, and we may suppose that, like bats, they could not take off from the ground, but climbed trees by means of their clawed fingers before taking flight. In spite of their bird-like head they are not related to birds; indeed, their modifications for flight are quite different, and much more like those of bats.

The flying mammals, whether they merely glide, or whether they flap wings, are all characterised by the presence of a double fold of skin that extends outward from the sides of the body to the limbs, known as the patagium, or wing-membrane. As will appear below, this has developed independently several times in different groups of mammals.

The phalangers are small arboreal animals of Australia and New Guinea, related to the kangaroos, and, like them, carrying the young in a pouch. The species are divided into several groups by structural characters, three such groups being characterised, amongst other things, by the structure of the tail, which in one has a series of long hairs along each side, in another is bushy, and in the third is prehensile, long and tapering, naked below at the tip. Each of these groups includes phalangers both with and without a patagium, so that it seems likely that this structure, and the habit of gliding, has been developed among the phalangers three times independently.

The pigmy flying phalanger is the smallest, a mouse-like animal, with a series of long hairs along each side of the tail. The patagium is a fold of skin extending from the elbow to the side of the body, and thence

W S Berridge

NIGHT-FLYING COBEGO OF MALAY

In Malay and the Philippine Islands there occurs an animal called the cobego or kaguan which is even better equipped for gliding than the phalangers, for its wing membranes extend between its fingers and toes. It is nocturnal and herbivorous.

outward again to the knee. These little animals live in trees and, with limbs outspread and patagium stretched, make big leaps from branch to branch, occasionally descending to the ground to run to another tree; they appear to be active during the day. Their flying membrane is hardly large enough to interfere with the free use of their limbs, and they are less specialised in their habits than most of the other flying mammals.

The other flying phalangers are larger, squirrel-like, and have a well-developed patagium that extends from wrist to ankle. With patagium spread they make enormous leaps from tree to tree, gliding obliquely downwards and ascending slightly as they reach their objective; a flight across a river, forty yards wide, starting from a height of thirty feet, has been observed. If alarmed they run to the highest branches and glide to another tree. The large flying membrane renders them clumsy on the ground, and they seldom or never leave the trees. They generally sleep during the day, concealed among the foliage, or in a hollow tree. At night they become active, and go in search of food, running along the branches and leaping from tree to tree. The food differs for the different species, but always is something to be found in the trees: insects, honey, leaves, flowers, or fruits.

The flying squirrels belong to quite another order than the phalangers, that of the Rodents, which includes rabbits, rats, and the squirrels that do not fly. All have a broad patagium, similar to that of the phalangers, between the limbs, and in some extending to the neck and to the tail. In the flying squirrels of North America, eastern Europe, and Asia, the flying membrane is supported in front by a rod of cartilage attached to the wrist, whereas in those of Africa it is supported by a rod of cartilage projecting from the elbow. These African flying squirrels are by no means closely related to the others, and are also distinguished by having a double row of spiny scales on the under side of the basal part of the tail, which assists these animals to climb trees.

Flying squirrels inhabit forests, and sleep during the day, either sitting high up in the trees, or hiding in hollow trunks. At night they go in search of food, fruits, insects, and so on, running along the branches and often making their way from tree to tree by alternate climbs and flights. They launch themselves into the air, and with patagium extended, glide obliquely downwards, ascending somewhat as they reach their destination; flights of fifty yards or more are not uncommon, and the larger squirrels of India may make flights of eighty yards.

The kaguan or cobego (*Galeopithecus*) of the Malay Peninsula and Archipelago is an animal of uncertain relationships, but perhaps allied to the insectivores and bats; it is generally placed in an order by itself. It is about as large as a cat, with long, slender limbs and curved claws, and with a larger patagium than any of the animals previously considered, for the fold of skin at the sides of the body extends not only from limb to limb, and to neck and tail, but between the fingers and toes.

Like most other gliding mammals it is nocturnal in its habits, and in the day-time rests clinging to the trunk of a tree, or hiding among the branches, where its brownish colour helps to conceal it. At night it feeds on fruit and leaves, and has been observed to go up a tree by short runs, and to make an oblique downward flight to a tree seventy yards away. A smaller species, with similar habits, occurs in the Philippine Islands.

BATS, which may be related to the insectivores or shrews, moles, hedgehogs, and so on, have a flying membrane similar in structure to that of the gliding mammals, as it is a thin fold of skin extending outwards from the sides of the body. The reader is referred to the photographs in pages 117 to 127.

The front limbs are very long, with very long and slender fingers; the wing-membrane extends not only from the side of the body and the hind-leg to the arm, but also between the fingers, so that there is a great expanse. The chest is large, with powerful muscles that move the fore-limbs, and with them the wing-membrane; the muscle that depresses the wing is the largest in the body, and the breast-bone is enlarged and bears a keel for its attachment. Bats

are thus capable of flight of quite another kind from that of the gliding mammals, as they beat the air with their wings.

BATS are a large and diverse tribe. Nearly all are nocturnal, during the day they rest head downwards, suspended by their feet, and with the wings folded. On the ground they can only shuffle along, but they are able to climb up trees or rocks with the aid of the thumb, which is free and provided with a curved claw.

The largest bats belong to the group known as fruit-bats, some of which have a wing-spread of five feet. The fruit-bats of India, Malaysia and Australia are sometimes termed flying foxes, they have short ears and fox-like faces. They roost on trees during the day, and at sunset fly off to places where trees are in fruit. They fly straight, with slow beats of the wings, and may travel long distances in search of food; in India they have been described as flying one behind the other in large companies. When feeding they generally hang on by one leg and grasp the fruit with the other. At dawn, when they return to their resting places, hundreds may settle on the same tree, and they scramble about upside down, each trying to get the best place. Some African fruit-bats have a large mouth margined by large flabby lips, which probably prevent the escape of the juice of the succulent fruits that they eat.

The smaller bats generally feed on insects, which they catch while flying. As a rule, they fly with more rapid beats of the wings than the fruit-bats, fluttering round trees, and twisting and turning in pursuit of their prey. Most of them have very large ears, and some have "nose-leaves" on the face, flaps of skin fringed with hairs, whereas others are provided with "chin leaves," lappets of skin below the chin; these appendages sometimes give the face a grotesque appearance, well shown in the photograph in page 118 There can be little doubt that these organs enable them to perceive obstacles, and perhaps also to detect insects. An experiment showed that in the dark bats were able to perceive and avoid a number of fine threads stretched across a room, for they flew between them.

During the day some insectivorous bats rest among the branches, others in hollow trees, or in caves or buildings. Not all eat insects, for in South America some skim the water and strike it to catch shrimps and fishes, and the blood-sucking vampires, with sharp-edged teeth, suck the blood of mammals while resting on or hovering over their victims.

The prevalence of nocturnal habits among the gliding mammals and bats is worth attention The advantage to harmless insectivorous or vegetarian animals of being able to fly from one tree to another without coming to the ground, and so avoiding carnivorous foes, must be considerable, but this involves the development of a patagium, so useful for flight, but somewhat of an encumbrance at other times, as for example when running or climbing are in progress.

The gliding mammals fly obliquely downwards, generally from the top of one tree to near the bottom of another. A climb has to precede another flight, and during this climb they would be exposed to attack. Inclined to be clumsy and slow except when flying, they find it safer to keep quiet during the day and to conduct their operations in search of food at night. The nocturnal habits of bats are doubtless inherited from gliding ancestors, and have been adhered to because it is not worth their

W S Berridge

MEMBER OF THE SQUIRREL FAMILY THAT HAS LEARNED TO FLY

This American flying squirrel makes a long oblique glide from the tops of high trees and can travel fifty yards or more, often altering the trajectory of the flight in an upward direction by virtue of the impetus towards the end of the glide. These creatures seek their food, which consists of insects and fruits, at night, and sleep during the day high up in the trees or else hidden away in some hollow trunk. By developing a wing membrane they have enabled themselves to become independent of the ground

W. S. Berridge

TREE FROG OF BORNEO

Some kinds of frogs living in Java and Borneo have developed the web joining their fingers and toes into broad surfaces with enough wind resistance to enable them to take great swooping jumps from bough to bough.

while to spend the day competing with insectivorous birds, or avoiding the attacks of predaceous ones.

We have seen that a patagium, or wing-membrane, has developed in mammals several times—perhaps three times in the phalangers, twice in the squirrels, and again in *Galeopithecus* and in the bats. None of the gliding mammals can be regarded as ancestral to the bats, but they have a similar wing-membrane connecting the limbs with the side of the body and, like the bats, rest in trees during the day and feed on fruits, leaves, or insects at night, when they perform their flights. They give us an idea of the structure and habits of the animals from which bats must have come, and if some gliding mammal with a large patagium and webbed fingers, like *Galeopithecus*, had tried to prolong its flights by beats of its fore-limbs it would have taken the first step towards becoming a bat; for the principal difference between the habits of *Galeopithecus* and of the fruit-bats is that these take longer flights by flapping their wings. The principal stages that have taken place in the evolution of bats may have been: (1) terrestrial mammals; (2) arboreal mammals that leap from bough to bough and tree to tree, like squirrels; (3) arboreal mammals that take long glides from tree to tree by means of a patagium, nocturnal in habits; (4) arboreal mammals with a patagium, flying by up and down beats of the fore-limbs, also nocturnal.

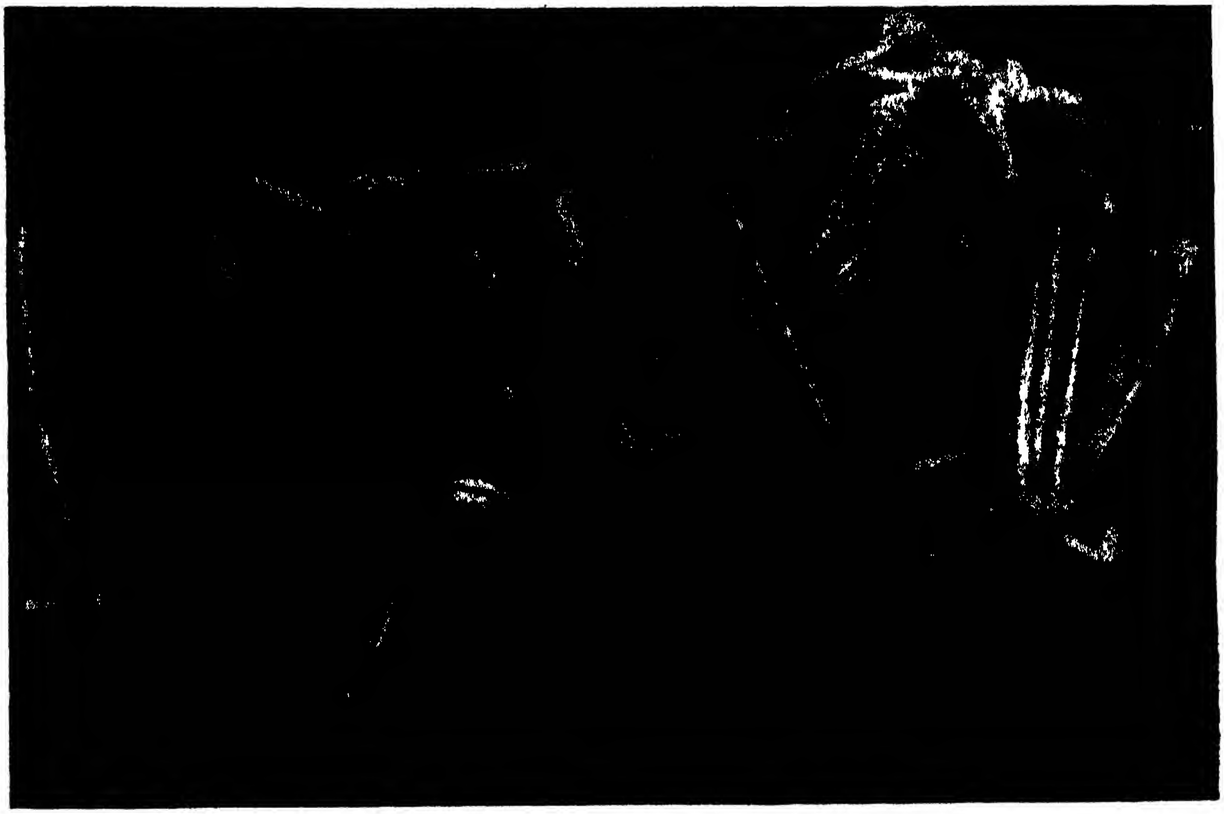
It is very interesting that millions of years afterwards bats should have developed the power of flight with wings so similar to those of the numerous extinct flying reptiles.

The probable evolutionary history of bats has been outlined above, but the question as to how these things have come about is still in dispute. Which is the more important, cunning or luck? as Samuel

W. S.

FLYING GECKO OF THE FOREST

Geckos form a part of the great lizard family, and of the many different species, over three hundred in number, there are some that are arboreal. Of these the frilled gecko is able to glide by an expanding skin on either side of the body.



NOCTULE BATS ASLEEP WITH THEIR YOUNG ON A BRANCH

Bats are the most efficient aeronauts of the mammals that fly, for they alone have solved the problem of continued flight and are not dependent on a mere glide like the phalangers. Indeed, the noctule, the largest of the bats found in England and common in the southern counties, is not inferior to any bird in its extraordinary facility in turning and twisting on its course as it flies in pursuit of the insects on which it feeds. The noctule's progeny cling to their mother sometimes till they are nearly as big as herself, as we see in the photograph.

Butler has expressed it. Are the effects of use and effort inherited and accumulated, or does evolution depend on the natural selection of certain small, favourable variations?

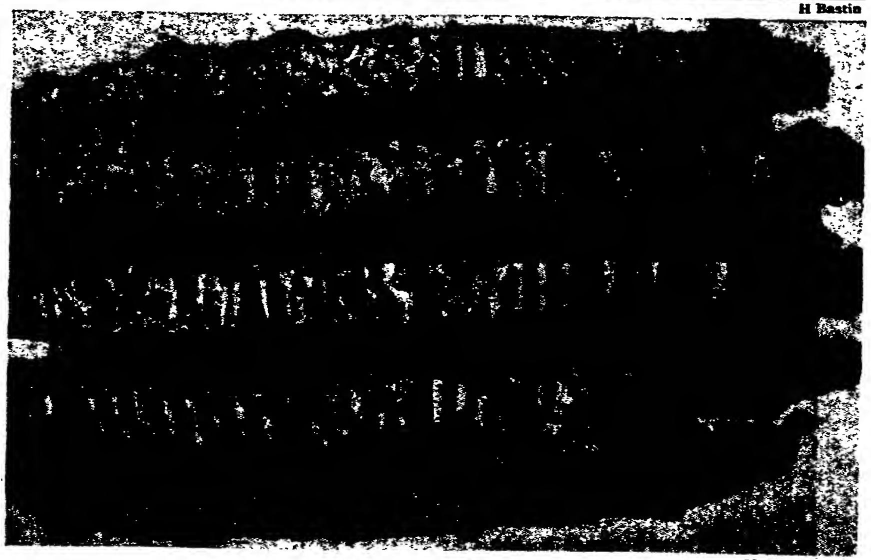
Let us take, for example, the pigmy phalanger, in which the patagium is least developed, extending only from elbow to body and out again to the knee. Did this begin as the stretching of the skin between limbs and body of an animal that leaped with limbs outspread, and did this effect continue and increase in further generations of animals with the same habit? Or was additional distance of leap so important that at first those phalangers with any fold of skin between limbs and body, and later those with bigger folds, on the whole survived and left more descendants?

THESE are the explanations according to the two chief evolutionary theories generally associated with the names of Lamarck and Darwin respectively, but it must be remembered that they are theories only. No competent student of the matter doubts that the remote ancestors of bats were terrestrial animals with normal fore-limbs, nor that they have evolved from these by some such stages as have been already described. What has happened, and why it has happened, is fairly clear; but how it has happened is another question to which we do not yet certainly know the answer.

If we compare flying mammals with birds we have to admit that birds excel; they have dominated the air for a long time, and have not left many places to be occupied by other fliers. The wing of a bird, as of a bat, is a fore-limb; but it is modified to support the light but strong flight feathers, and is not connected by a membrane with the body and hind-limb. This difference is of the greatest importance; it gives the wings greater freedom and a better shape, allows the body to develop the rounded, tapering contour essential for swift flight, and permits the hind-limbs to be used as legs, so that when not flying birds can stand, hop, or run. Moreover, they can take off for a flight direct from the ground, and in this, as in most other respects, are definitely superior to the bats.

The flight of birds by beats of the wings is essentially similar to that of bats, but most birds exceed bats in speed. Some small birds may be seen to follow a short upward flight by an oblique downward glide comparable to that of a flying squirrel, the long horizontal glides of some larger birds appear to be accomplished by taking advantage of air currents.

H Bastin



M. H. Crawford

NESTS OF WASPS AND HORNETS AND A PIECE OF WOOD AFTER "WORKING"

Wasps and hornets construct their nests out of a kind of wood-pulp made by scraping the surface off a piece of wood and chewing up the fragments and mingling them with saliva. The pulp so prepared is spread out in layers and then moulded to the required shape. The top left-hand photograph shows a queen wasp at work scraping material for wood-pulp from a fence, while the top right-hand photograph is of a piece of wood after it has been scraped by nest-building wasps. The nest of the tree-wasp (top centre) is made in the same way. The wood-pulp is not altogether waterproof, and nests sometimes get flooded out in a wet summer. The bottom photographs show (left) a hornets' nest, and (right) five pulp combs of a wasps' nest.

Chapter XLI

Carpenters and Joiners and other Workers in Wood

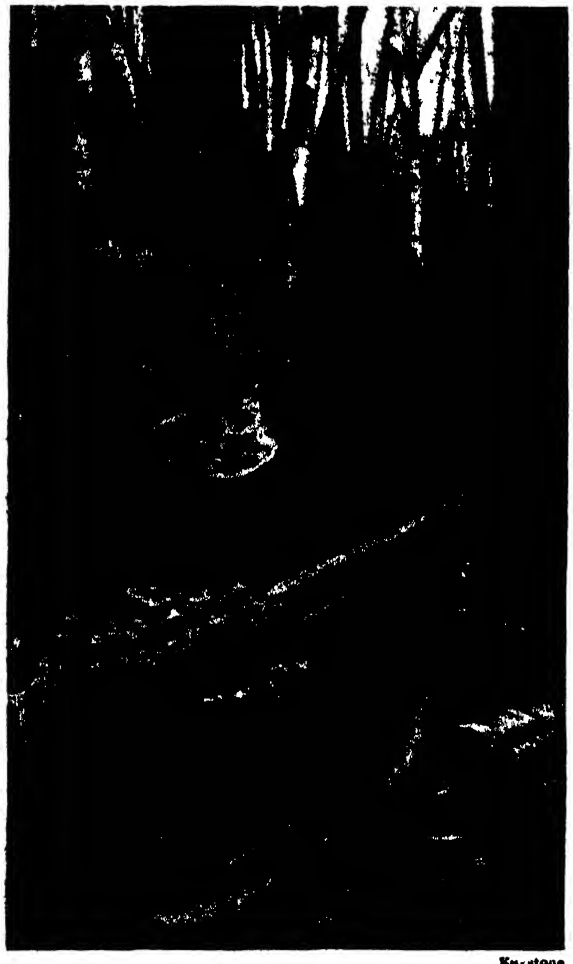
By Henry Neal Milligan

Zoologist of the Horniman Museum

Many readers will no doubt be surprised to learn that there are animals which are "carpenters and joiners and other workers in wood." But some of man's best inventions were anticipated in nature, and certain instruments of carpentry were employed by animals long before the human era.

Take, for example, the chisel. Probably few people will think of carpentry without thinking of chisels. But what, it might be asked, have animals to do with chisels? We can turn for answer to an animal which nearly everybody has kept as a pet, namely, the rabbit. A rabbit will persistently gnaw the woodwork of its cage, and it does this by means of certain peculiarly-formed teeth. One need do no more than glance into the animal's mouth to see the teeth, for they are those four (two upper and two lower) which are at the very front, but if the reader can examine a skull he will be in a better position to understand the matter. Each of those four teeth is a chisel.

Each tooth is mainly composed (like our own teeth) of dentine, coated outside with enamel, though in the rabbit's teeth the enamel is chiefly on the front surface. Now, the dentine, though hard, is not so hard as the enamel, and wears away with use faster than the latter. Consequently, the working surface of the tooth has always an upstanding front ridge of enamel, backed by a body of dentine; and however much the enamel wears with use the dentine behind it wears faster, the relative proportions of the two materials being thus always preserved. Such is the structure of the four front chisel-like teeth of the rabbit. And such, indeed, is the structure of a man-made steel chisel, for it is composed of a thin and very hard layer of metal supported by another thick but not so hard layer.



Keystone

BEAVERS AT WORK

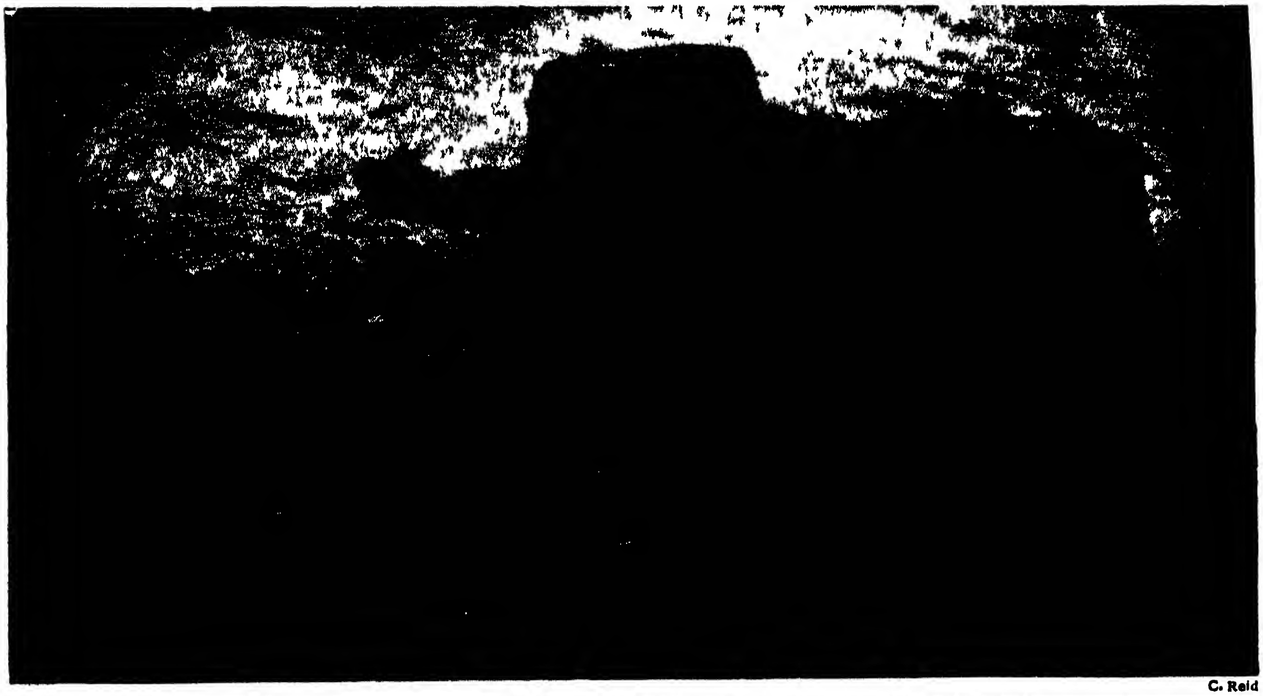
This drawing shows how the beaver gets through its work. The trees and branches are cut from upstream and floated down to the proposed site of the dam. There they are cleverly arranged and then plastered with mud and pieces of turf.

With its front chisel-like teeth, then, a rabbit gnaws. This peculiar habit has earned for animals like rabbits the general name of rodents or gnawers. There are many kinds of rodents, including, besides rabbits, such creatures as guinea-pigs, rats, mice, beavers, and squirrels. All rodents find their chisels very useful, for not only can these teeth be used to chip pieces from hard food, but, as in the case of the squirrel to chisel off the shells of nuts, or to cut through obstacles in the way of burrows and runs. Gnawing is very wearing to teeth, and the chisels of rodents, unlike ordinary teeth, are always growing, the material which is lost at their ends being made good by the addition of new material at their bases. Man has made good chisels, but he has not made one which grows as it wears! But teeth which are always growing may sometimes be troublesome. Suppose, for example, that a rodent does not use its chisels sufficiently, or that they are somewhat misplaced, or that one chisel breaks and leaves its opposite nothing to bite against. In such cases the teeth grow too long, and may not only interfere with feeding but even pierce and injure the head. Healthy rodents instinctively gnaw such substances as wood, thus keeping their teeth in good condition, and it is this instinct which leads captive specimens so persistently to perform the seemingly useless carpentry of cutting away the woodwork of their cages.

The rodents we have mentioned are all carpenters, but one of them, the beaver, is a joiner as well. The beaver feeds on the bark and leaves of

BEAVER AND ITS CUNNINGLY CONSTRUCTED "LODGE"

Besides building a dam across a stream, the beaver has also to construct out of it the "lodge" in which it lives and, furthermore, to keep the whole in repair One entrance to the lodge is from the bank, and there is also an emergency entrance below the surface where the water is deepest Some lodges, however, are completely surrounded by water The whole structure is a complex of tree trunks, branches and twigs held together by skilful arrangement, the pressure of the water, and a plastering of mud which the animal makes with its fore-paws



C. Reid

CARPENTER, JOINER, AND PLASTERER IN ONE THE BEAVER

On land the beaver is not an active animal It is much more at home in the water, and deep water is safer than shallow The beaver then, likes plenty of depth in his stream, and has learned how to dam up the water for the purpose, and it is the American beaver that is the finest dam builder A tree is selected for felling, and the animal gnaws a furrow round and round the trunk, and the rasping of its chisel teeth can be heard at quite a considerable distance When the right number of logs have been cut, the beaver joins them together in a dam

M. H. Crawford

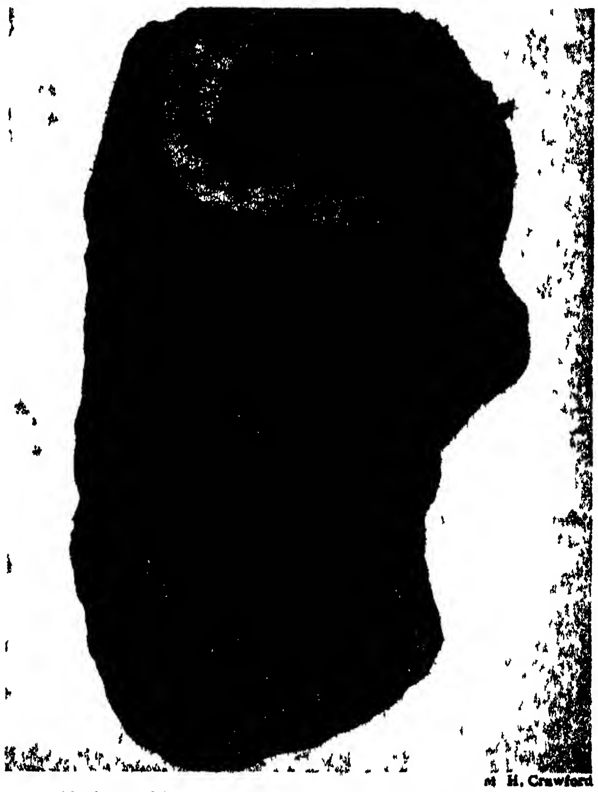
WOODPECKER AT WORK ON A TREE

Working as quickly as a mechanical drill the great spotted woodpecker's beak is moved by especially developed neck muscles. It taps tree bark for insects and drills out a shaft in the trunk for its nest

trees and on aquatic plants, and lives preferably in a district well timbered and with a stream flowing through it. Across such a stream the beaver will build its famous dam. It should be mentioned that beavers occur in Europe, Asia, and North America (though sadly reduced in numbers through man's persecution), but it is chiefly the American beaver whose dam-building is so remarkable.

THE dam is composed mainly of trunks and branches of trees, and to obtain these the beaver must in many instances actually fell the trees. Here the powerful chisel-like teeth are employed with good effect. The beaver cuts a furrow round and round the base of a tree, working with such vigour that the rasping sound may be heard a long way off, and sooner or later the tree gives way and falls, usually towards the stream. The tree is dragged and pushed to the water, unless it is large, when it is cut into lengths and brought to the water in sections. The various pieces of wood are thrust together, and finally intermingled in such a way that they make a firm and massive fence across the stream. The beaver now adds the work of a plasterer to that of carpenter and joiner, thrusting such materials as mud and sods well into the interstices of the fence so as to make a wall which is nearly impervious to water. The beaver, it must be explained, plasters with its front feet; the old story that its great flat tail is used trowel-wise, is not true. The stream, stopped by the dam, soon forms a lake. The beaver, always on the alert, discovers and repairs injuries to the dam. Instances have even been described of the animal making a "slipway" for superfluous water.

A wonderful performance, indeed. But, why the dam? A beaver is not an active creature on land, and it prefers the water, in which it swims and dives with ease. It is much safer in its artificial lake than it would be on land, or in a stream. Moreover, the entrance to the beaver's home is made secure by being concealed under a large mass of water. Again, the beaver needs to make a store of food for the winter, and when such food is an under-water store, as it is in this case, it is convenient to have a safe way to

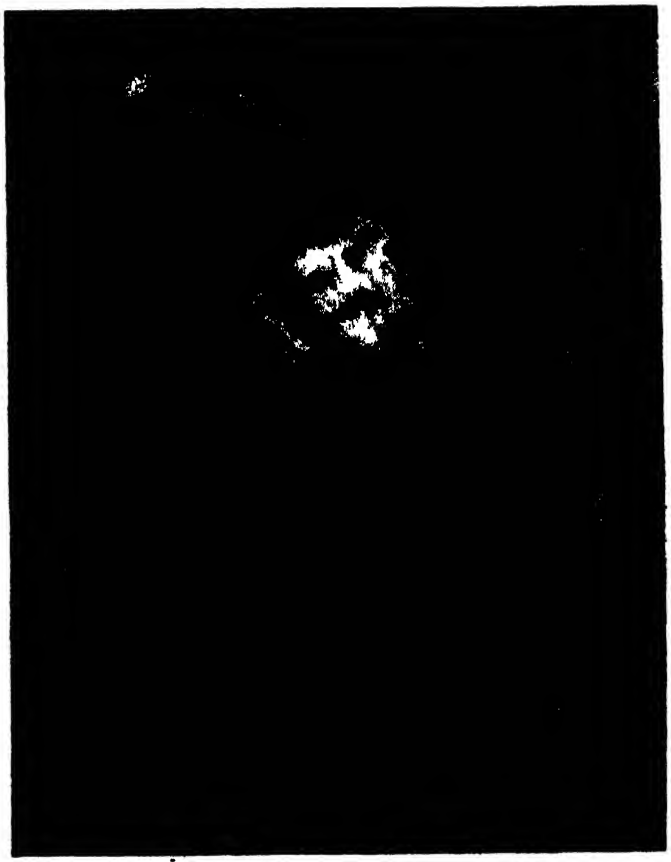


M. H. Crawford

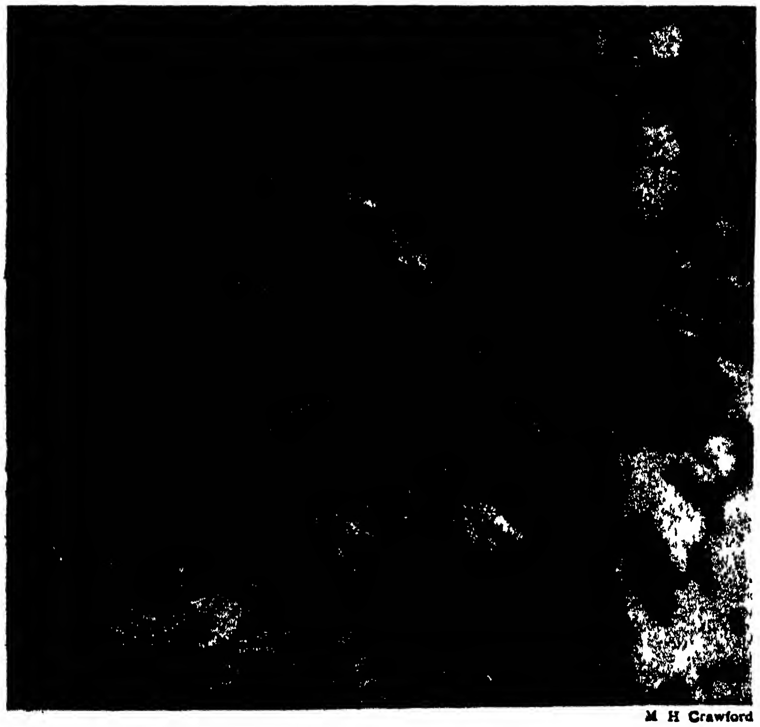
NEST-HOLE DRILLED BY WOODPECKER

This is a piece of a tree trunk that has been very neatly drilled by a woodpecker for nesting purposes. When the tree was cut down this log sawn from it would have made a convenient nesting box for other birds in a garden.

it, particularly when the surface of the water is frozen. The beaver's home, or "lodge," is built, on the bank of the stream, of branches, twigs, and mud, and a burrow leads at one end into the home and at the other to an under-water entrance. Some of them are simple and others fairly complex, and certain examples are wholly above water, resting on "islands" constructed by the beaver with branches.



THERE are many birds which are workers in wood. One which quickly comes to mind is the English green woodpecker. Fairly open woods and large well-timbered parks, particularly those with old trees, are the places beloved of this bird. If we are fortunate, we may see it ascend the trunk of a tree, advancing, often in a spiral course, with short jerky motions, tapping sharply at the bark with its beak as it goes. It wants to dislodge loose bark, and thus secure the insects which are beneath. The suitability of the beak for such a purpose is clear enough, for it is like a pick. It is long, strong, straight, and pointed, and the head which carries it is moved by powerful neck muscles. The hewing powers of the green woodpecker are considerable, but they are outdone by those of the American ivory-billed woodpecker. One of these last-named birds was caught by a naturalist, Alexander Wilson,



M H Crawford

PICK-LIKE BEAKS OF NUTHATCH AND WOODPECKER

Armed with a strong pick-like beak the nuthatch (bottom) got its name from its method of dealing with hazel nuts. The bird gets the nut into a crevice and then drives at it with its beak until the shell is broken. The lesser spotted woodpecker (top) is another among British birds which are workers in wood

and it ruined a mahogany table by striking out great pieces with its beak! The beak of the woodpecker is also used for making a nesting-hole in some tree in which decay has rendered the wood easily workable. A horizontal shaft is first picked out, and, leading from that, a vertical shaft. At the bottom of the vertical shaft is the nest.

One may call it the "nest," but truly it is simply the enlarged lower end of the vertical shaft, the fine chippings produced during the work being used as the bed for the eggs and young.

Some birds build nests of wood, and of these the rook is an example. A rook makes its nest along with other rooks in a sort of community or rookery, building as nearly as practicable at the top of a tall tree, several nests, perhaps almost or quite touching. The nest is made of pieces of tree-wood, some pieces being little more than twigs, whilst others are relatively thick branches. The joinery involved in putting together the pieces of wood is not so simple a matter as might be supposed, for much time is spent in selecting the wood, breaking it up, and interlacing the pieces. The wood is often plastered

King & Son

but let us now examine a piece of wood into which ship-worms have bored.

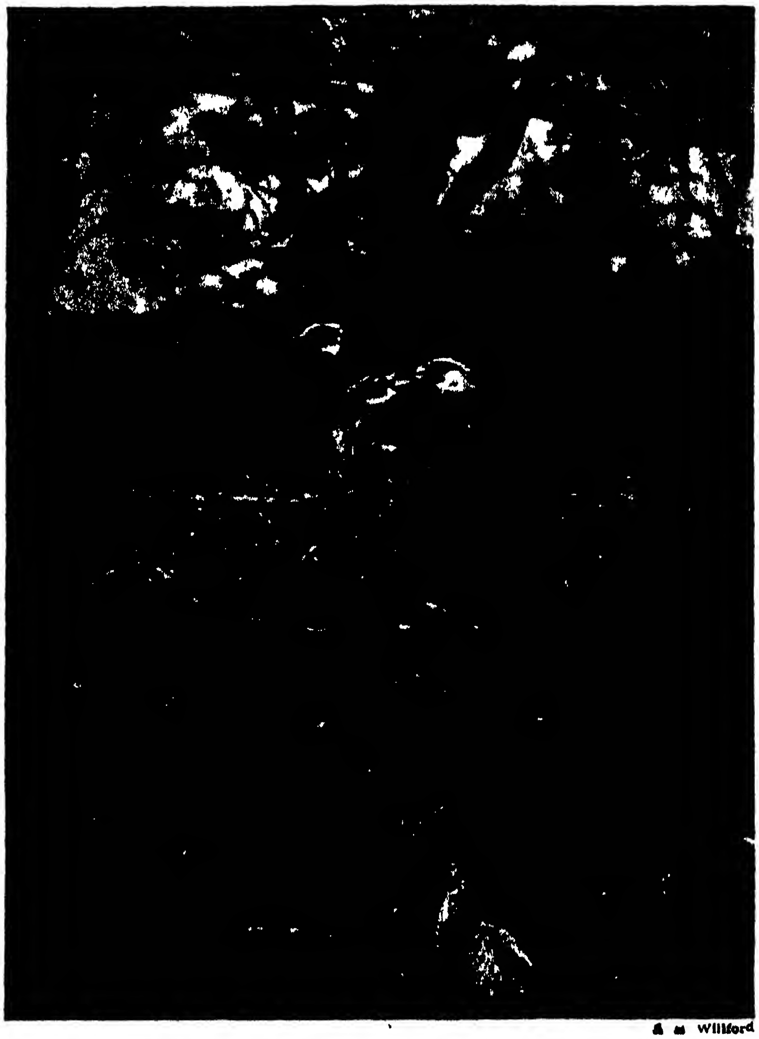
This may be of deal, or hard oak, or harder teak, but, whatever the material, ship-worms have cut smooth passages in it and reduced it to a mere shell of wood, with partitions, often not thicker than paper, between the passages of individual animals. Each teredo has lined its passage with shelly matter. It is thought that the passages are rasped out by a rocking motion of the rough shell, and some people have asserted that grating sounds can be heard when ship-worms

with mud, and the interior of the nest finished off with turf, leaves, feathers, and so on. It is surprising that a bird can do so much building with its beak.

The creatures already mentioned belong to the higher sorts of animals, but others have ability to work in wood. Indeed, the best workers belong to the lower groups. There are so many of them that a bare list of their names would take up our space, and we can therefore describe only a few representative kinds, including the ship-worm and some insects.

WHO has not heard of the ship-worm? We all call it the ship-"worm," for it is not unlike a worm in appearance, but truly it is an animal of the group Mollusca—the group to which mussels belong. Sometimes, however, it is called the teredo. Now, the ship-worm or teredo is a famous worker in wood. Formerly it was dreaded by those who had to do with wooden ships and piers, and, in some places, it still is dreaded, although since metal has been much used in marine work its operations have not been so formidable. Let us glance at a preserved ship-worm, as we may do in almost any museum. The animal is perhaps eight inches long with a tiny two-valved shell at one end and two fleshy tubes at the other, and the outer surface of the shell is rasp-like.

The teredo seems so much like a helpless worm that those who have read of its ravages may be surprised, and perhaps a little amused, when they first examine it. It seems impossible that such a thing could vex marine engineers and alarm ship-owners,



A. M. Willford

BIRD JOINERY: HERON'S AND CORMORANT'S NESTS

In high trees or sometimes on sea-cliffs or even ruins, the heron build its great nest among a colony of its own kind. The nest (bottom) is flat and broad and consists of twigs and grass on a foundation of branches. The cormorant, unlike many sea-birds, makes a proper nest of twigs and seaweed (top).

A. H. Willford

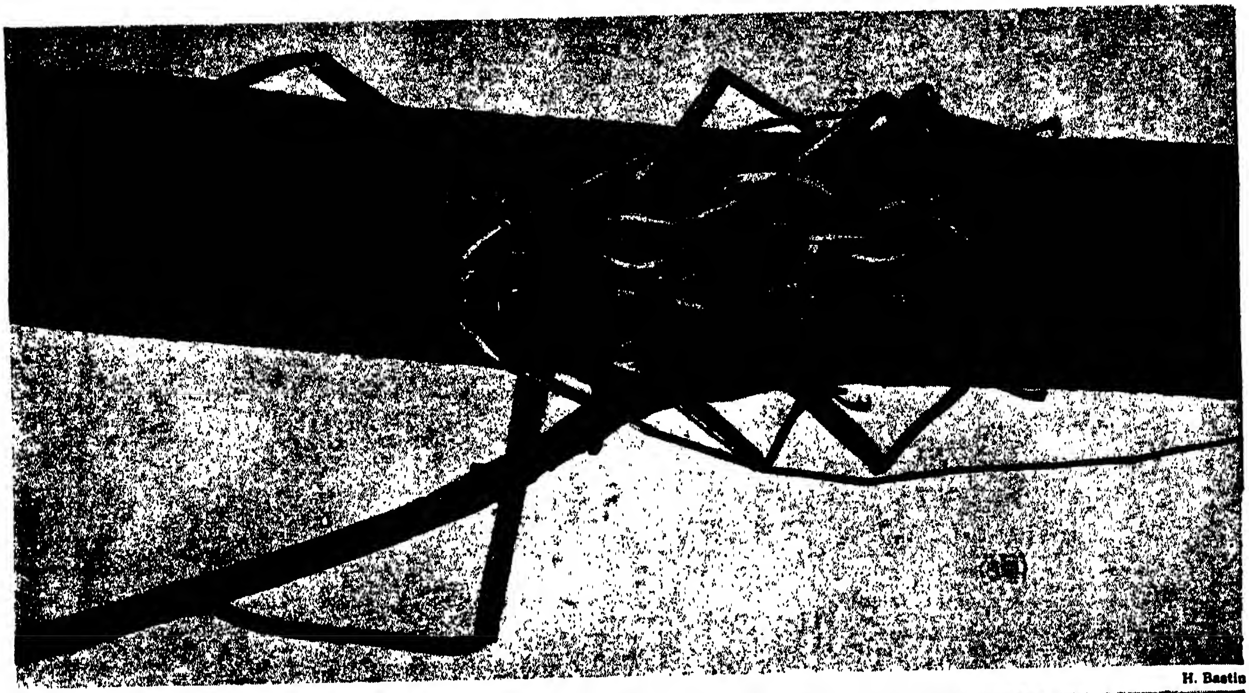
BIRD JOINERS IN THE TREE TOPS: A ROOKERY AND ITS INHABITANTS

This fine photograph shows a busy rookery when the young are growing up and clamouring for food. Some of the parents are attending to their offspring, while others are circling above in the way rooks have. The nests are built up much more carefully than would appear. Great pains and much time are taken over choosing suitable branches and twigs and in breaking these up and putting them together. Often the wood is plastered with mud. The nest has to be strong enough to withstand a high wind.

are working. The animal works fast, and as it reproduces rapidly (the young being free-swimming, and thus able to spread), it may soon do enormous damage to woodwork in the sea.

Holland has suffered severely, for the dyke-piles have been injured, and even threatened with destruction, by ship-worms. It is a bad pest, however, which does nobody good, but it is well to remember that it was the shell-lined passage of the teredo which suggested to Sir Marc Isambard Brunel a means of making the first Thames tunnel. The ship-worm obtains security by burrowing in wood; but it also obtains food, if it be true, as some zoologists believe, that the animal eats fine fragments of wood.

Among the insects mention must be made of the giant sirex, a creature related to the wasps. It is



H. Bastin

J. J. Ward

HUGE GOLIATH BEETLE AND THE HARLEQUIN BEETLE LIVING ON TREES

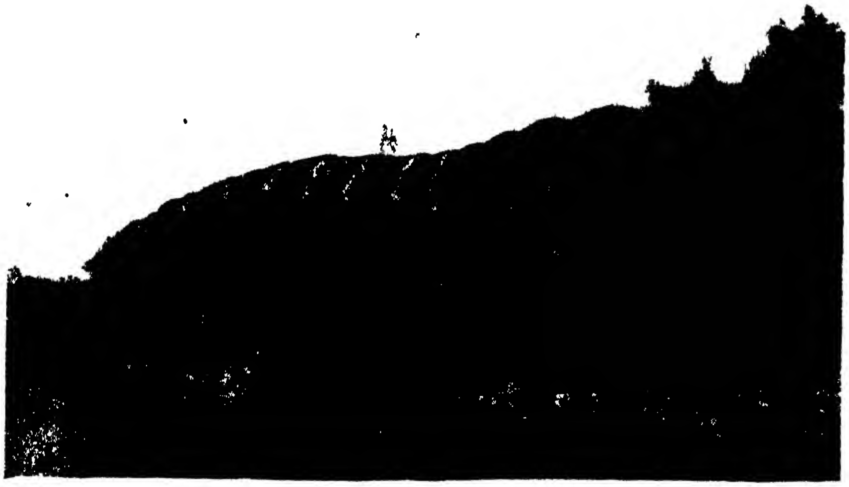
Probably the largest of all the beetle tribe is the goliath beetle (bottom) of Africa, which is almost as large as a man's fist. We see it here with its wings partly expanded from the wing cases. It does considerable damage to wood. Tropical America is the home of the harlequin beetle (top), a very beautiful creature possessing remarkably long front legs and remarkably patterned wing cases. It is a poor flier, but gets about the trees in which it lives and feeds by swinging itself from branch to branch.

H Bastin

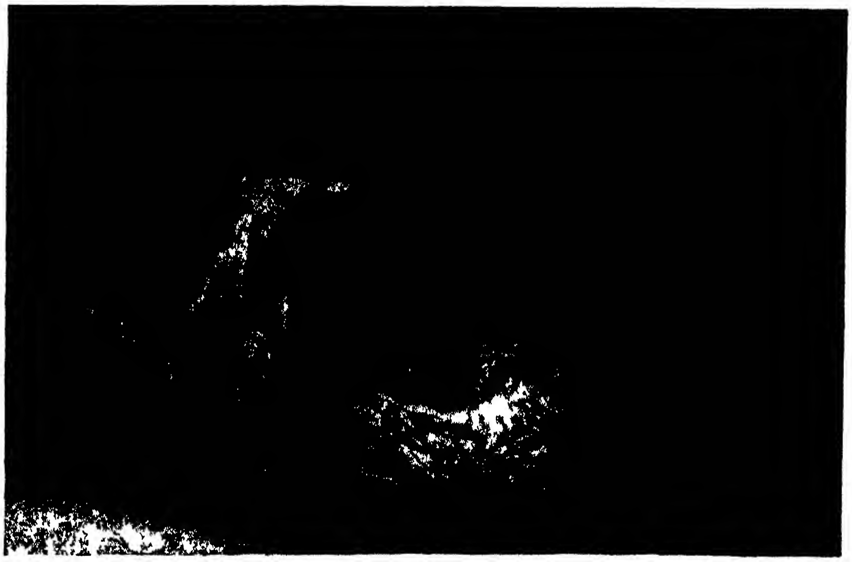
J J Ward

BUSY CARPENTER ANTS AND THE STAG BEETLE

Carpenter ants (bottom) are very careful not to reveal the presence of their nest by leaving sawdust lying about near the entrance to their communal home The two seen here are engaged in this work of concealment The one on the left is half emerged from the entrance hole and is handing a fragment of wood to a porter ant for removal Above is the stag beetle whose grub causes much damage to oak trees The bottom photograph is by Paul Griswold Howes, Assistant Curator of the Bruce Museum, Greenwich, Conn , U S A



J. T. Roberts



J. T. Roberts

GOAT-MOTH CATERPILLAR: A GREAT WOOD BORER

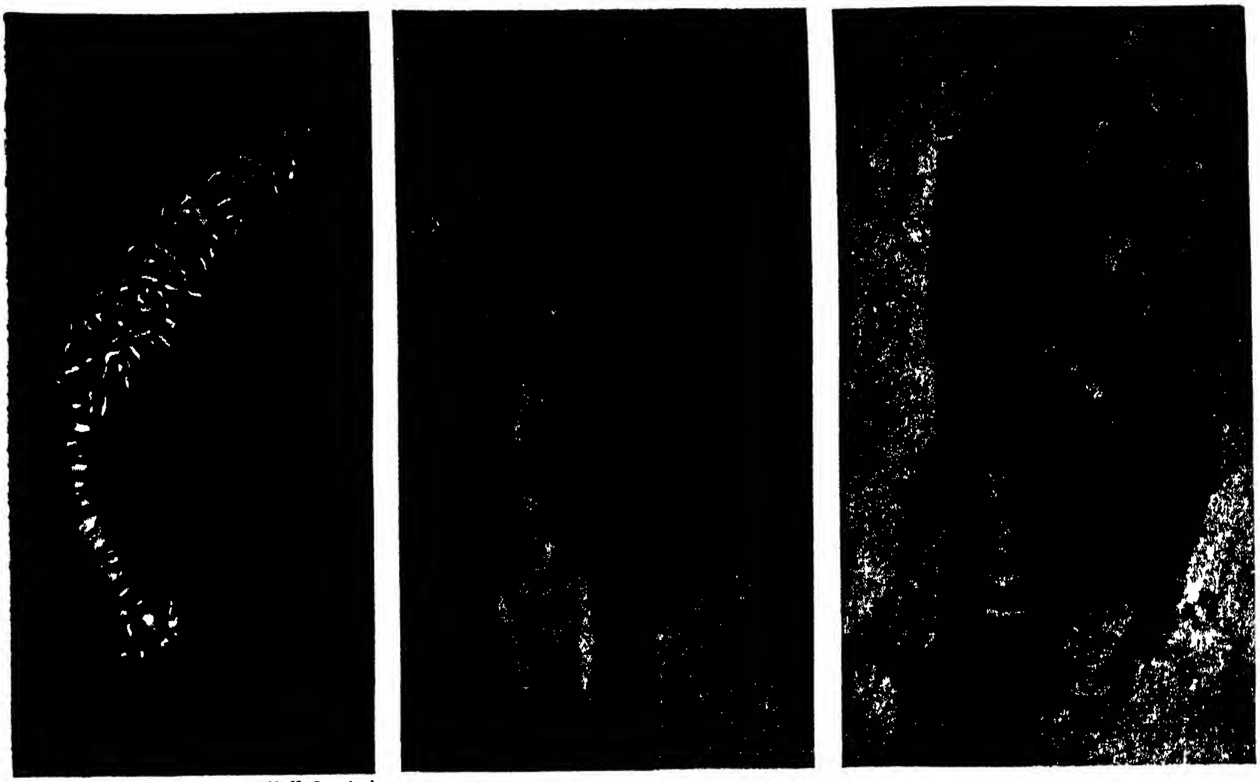
The eggs of the goat moth are laid in cracks in wood and the caterpillar, when it hatches out, is a large and powerful grub (top) with the characteristic goat-like smell and a very hard wedge-shaped head and big jaws. It eats long tunnels through the wood and just before it becomes a pupa makes itself a cocoon of wood chips fastened with gum from its mouth (bottom).

nearly as big as a hornet, banded with black and yellow and the female, though not really dangerous, is a terrifying creature, for it bears a conspicuous sting-like appendage at its hind end. It is not common enough to be often seen, but sometimes it issues from the woodwork of new houses, and when it does so not unnaturally causes much alarm, especially if it appears in numbers. The explanation of such visitations is this. The supposed sting is a borer-like egg-layer, and with it the female bores holes in trees (preferably dead or new-felled fir), in which she lays her eggs. From each egg hatches a creature, which, as in all the higher insects, is not a miniature copy of the adult, but is a grub or caterpillar. The grub lives in the wood, and eats it, making long passages in doing so, and wood infested with many grubs may be quite riddled. Before any grub becomes a perfect insect it passes through a quiescent stage, called the pupa. Our sirex grub, just before pupation, approaches the surface of the tree, and, when it has become a sirex, pushes its way out of the hole. Hence the sudden appearance of such insects from wood not seasoned.

The sirex merely bores holes for the eggs, and the grubs eat the wood with their hard jaws. But in certain related insects, called carpenter-bees, it is the mother who cuts channels with her jaws. The fine European violet carpenter-bee is an example. The female cuts out of dead dry wood a short horizontal passage, leading into three or four vertical passages, and in the latter she lays her eggs, dividing the eggs from one another by horizontal partitions made ingeniously of wood chips.

Another insect, belonging not to the wasp-and-bee group but to the moth group, which lays eggs in wood, is the British goat-moth. The moth has no borer, and simply lays her eggs in cracks. The grub is a big, fat, fleshy, repulsive creature, with a hard wedge-like head and great jaws, and with a goatish smell. It eats long wide passages in the wood, and is often called the auger-worm. Just before it becomes a pupa, when it is nearly four inches long, its woodworking instincts take a fresh turn, and it makes a sort of protective covering or "cocoon" out of wood chips, which it fastens together with a gummy substance from its mouth.

There are many other woodworking insects. Amongst the beetles they are numerous. The British stag-beetle is one whose grubs are very destructive to oak trees. Other destructive species are the bark-beetles, one of which, known as the elm bark-beetle or scolytus, may be particularly mentioned. This beetle is about a sixth of an inch long. The female eats into the bark of an elm tree, and then, turning at right angles, eats out a passage between bark and wood, laying about a hundred eggs at fairly regular intervals in this passage. Each grub eats a passage at right



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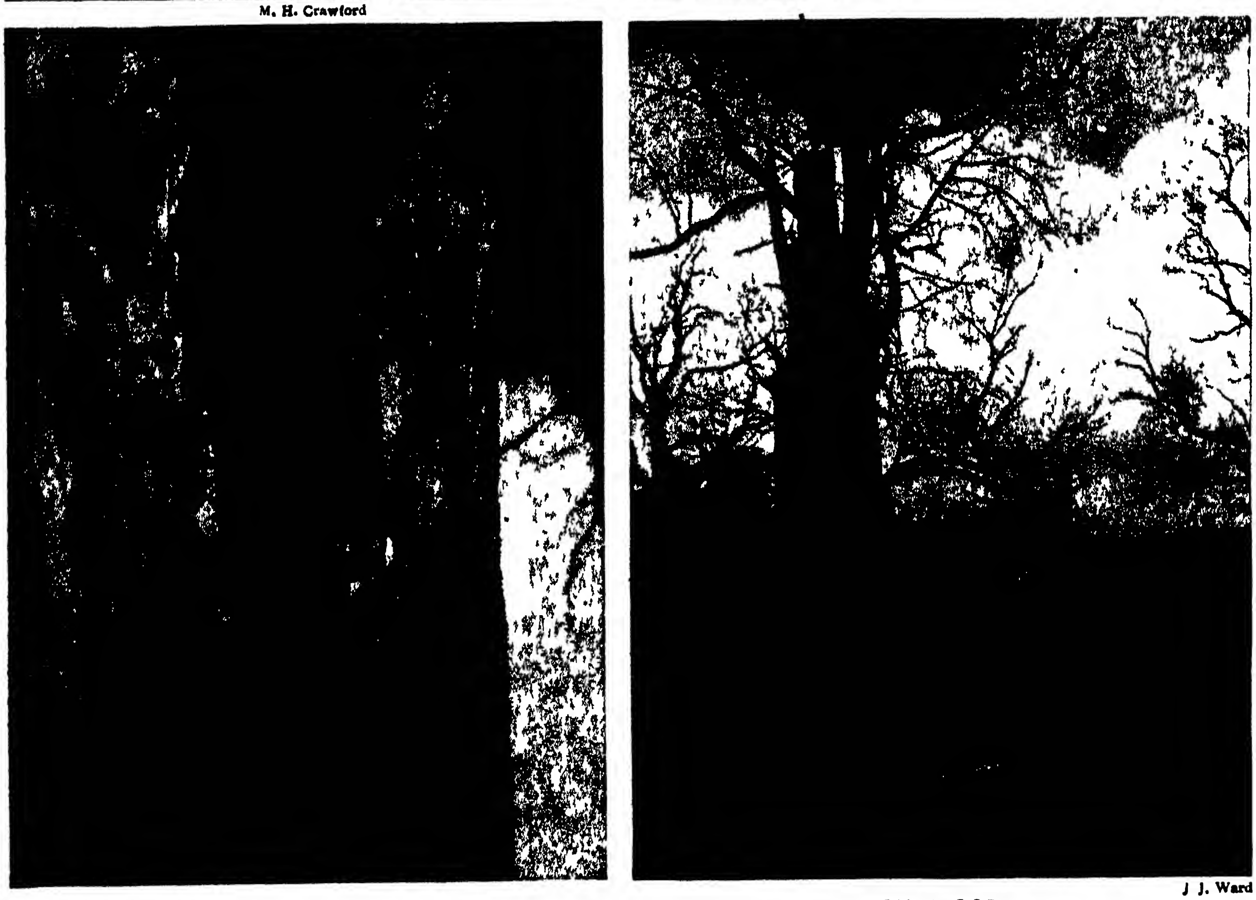
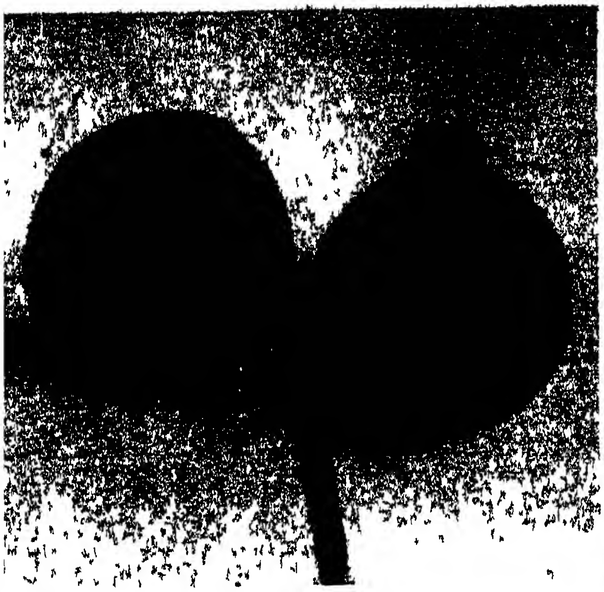


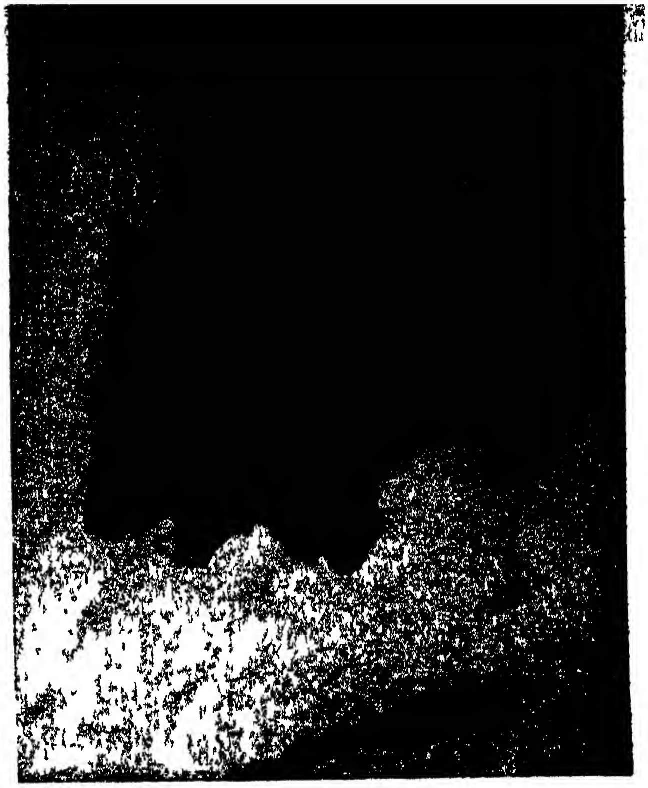
J. J. Ward

GOAT MOTH AS IT DEVELOPS AND ITS EFFECT ON WOOD

How wood can become riddled by the depredations of the goat moth larva may be seen from the two lower photographs The ash tree shown has suffered in this way so much that its existence is threatened by the next storm Above are the three stages through which the moth passes. The larva (right) feeding on a tree is busy with its strong sharp teeth Eventually it makes itself a sheath of wood chips This " cocoon " (left) was taken from the ground after the moth (centre) had emerged and shows the empty pupa skin projecting.



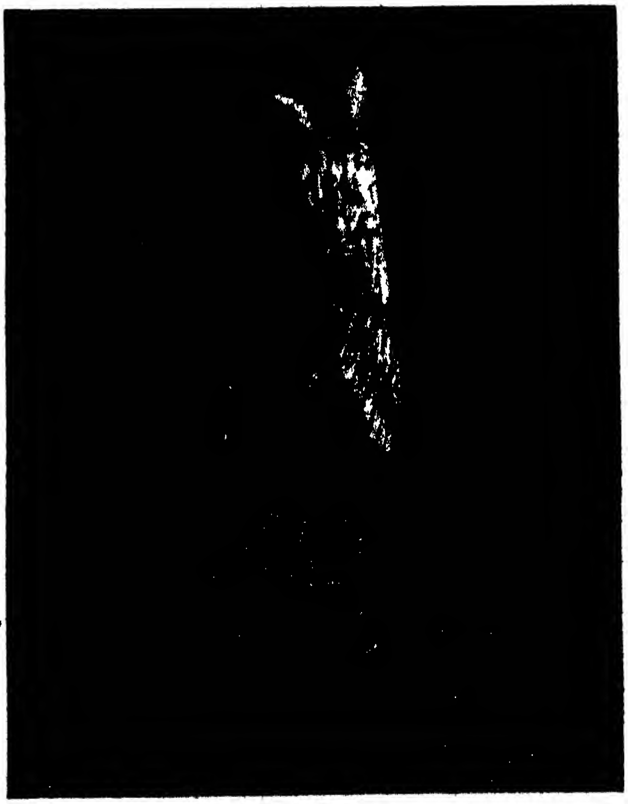
Oak Apples



Puss-moth cocoons

Root Galls

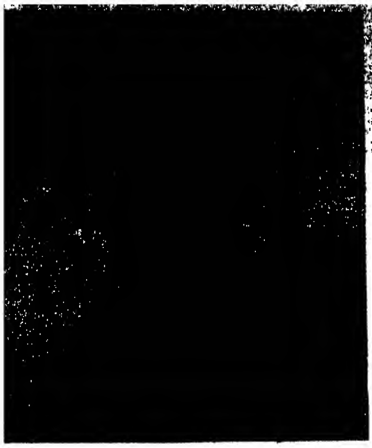
Nut Weevil and its work



Puss-moth and empty cocoon

INSECT CARPENTERS OF NUT, BARK, ROOT AND GALL

The nut weevil has a very long proboscis and when it has, as a larva, eaten all the contents of a nut bores its way out through the shell. The gall-flies lay their eggs either in wood or roots, and here are the oak apples and root galls, swellings caused by abnormal cell development round the puncture made by the parent insect in depositing the eggs. In the photograph of the root galls, the lower right gall has the larva's exit hole. The other photographs are of the puss-moth, which fashions its cocoon from bark and wood. These photographs are by Mrs. M. H. Crawford

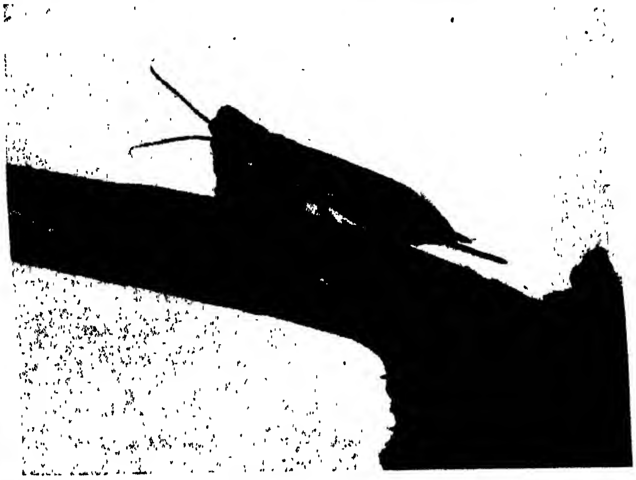


A caterpillar's home

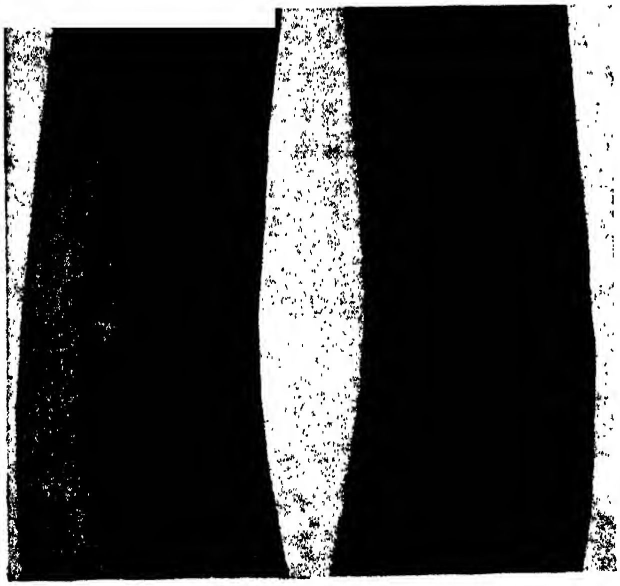
Orange clear-wing moth just emerged

Caterpillar at home

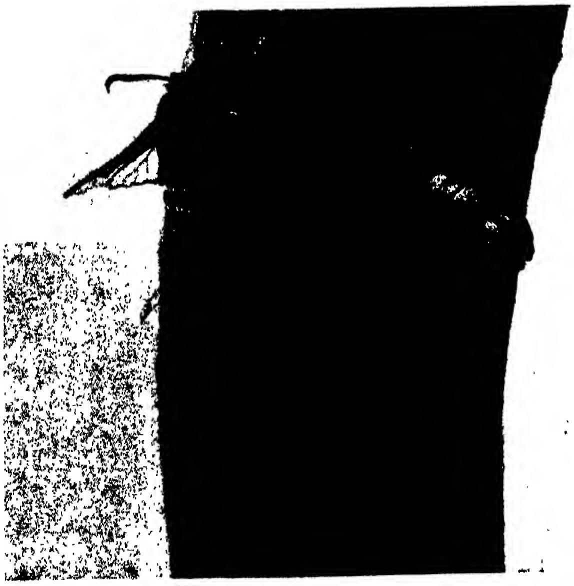
Top view of female sirex



Side view of sirex



Larva of lunar hornet-moth



Lunar hornet moth and empty pupa skin

INSECTS WHOSE EGGS PRODUCE WOOD-BORING LARVA

In the bottom photographs we see (right) a lunar hornet-moth (left) just emerged from its pupa skin. In the left-hand photograph is a branch split to show the tunnel bitten out by the larva of the moth. The path is barricaded just below the larva and also at the entrance of the hole. The female sirex (middle photographs) is like a large wasp with a long sting. In reality the "sting" is harmless and is an ovipositor which bores into wood and lays the eggs. The orange clear-wing moth (top) is shown with some of its work. The photographs are by J. J. Ward.

TIMBER CUT FOR MAN, AFTER IT HAS BEEN USED BY SOME OF NATURE'S WOOD-WORKERS

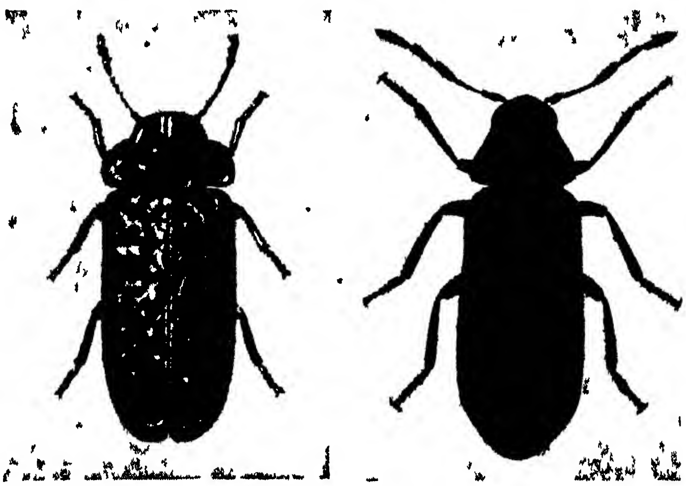
Ravages by the death watch beetle may cause the collapse of a building The mating call, caused by the striking of its head against wood and producing a sound like the ticking of a watch, gave the beetle its name The left hand photograph shows some irrevocably damaged woodwork from the interior of St Clements, Eastcheap, one of the old City churches The centre photograph is of some oak from a breakwater, destroyed by the teredo, a wood-worker of the sea, while on the right is a timber marked by the shot borer beetle

angles to the mother's passage, and all the passages together make a curious and characteristic radiating pattern, which may be seen when the bark is lifted from the wood

Everyone has seen the neat round "worm-holes" in furniture The animals which make these holes are usually called "worms," but the reader will probably guess that they are really grubs of insects They are the larvae of furniture-beetles Much damage may be done by these grubs The writer was recently shown the remains of a picture-frame so riddled by grubs that it was little more than a husk filled with powdered wood The great injury done to the old oak beams of the roof of Westminster Hall is fresh in all our minds

There are several kinds of furniture-beetles in England but one kind is particularly common It is about a sixth of an inch in length, of rather elongated and compact form and of a brownish colour Most people have found examples living or dead, in houses in which there is infested wood, and those who have watched a living specimen must have noticed its curious habit of "shamming dead" The female lays her eggs in crevices or holes in wood, and the whitish grubs, with their powerful jaws, eat long passages in it about a twelfth of an inch in diameter Tiny heaps of wood dust appear under infected furniture When the time of pupation draws near each grub comes almost to the surface of the wood, where it becomes a pupa, and there remains until, as a perfect beetle, it is ready to bite its way out. The hole through which it emerges is henceforth a "wormhole." Furniture-beetles creep and fly about, and thus carry infection from wood to wood The tapping sounds, known to the superstitious as "death-watch," are really sex-calls from one furniture-beetle to another, made by knocking the head against the wood

Animals which work in wood, then, are of most various kinds Some of them cut into wood with chisel-like teeth (rodents), or pick like beaks (woodpeckers), or borer-like egg-layers (giant sirex), or rasp-like shells (shipworms) Some use wood for building homes (beavers) or nests (rooks) To make a hole in a tree is a good way of obtaining safety for eggs and young (woodpeckers), whilst those which both live in wood and eat it (shipworms, insect grubs) are unusually fortunate and safe. Finally, it should be observed that, many and diverse as are the examples which have been mentioned in this chapter, they are few compared with the many which exist.



DESTROYERS OF WOODWORK

The furniture-beetle (right) lays its eggs in crevices of wood When the grubs hatch they eat their way inwards till as pupae they return to near the surface, eating their way out on hatching The death-watch beetle (left) greatly damaged the roof of Westminster Hall Photographs by courtesy of British Museum

Chapter XLII

Is Evolution Still Going On?

By Professor J. Arthur Thomson

Author of "The Gospel of Evolution"

WHAT is Evolution? In the wide sense it is a process of becoming, in the course of which something new arises. There is no doubt that new stars are still appearing in the sky, and there are nebulae which seem to be making new solar systems far away in space. If some stars die into darkness, other luminaries are being born. For the universe as a whole there does not seem to be any evidence of either its ending or its beginning. Within our intellectual horizon there is a ceaseless flux. Cosmic evolution is going on.

At present, within the chemist's reach, there are ninety-two elements (less four gaps still to be filled); and we know that a kind of chemical evolution goes on. Thus uranium may give rise to ionium, which may give rise to radium. Or uranium may give rise to protactinium, which produces actinium, which produces lead. Or radium by giving off helium may produce lead. The meaning of this is that all the different elements are composed of positive hydrogen-nuclei or protons in the centre of the atom, and negative units of electricity or electrons in zones outside. An average atom is like a sun and its planets. There is a solar core of protons, and outside this there is orbit after orbit of electrons. Even as we write this the picture of the atoms is changing a little, but the large fact is secure that the 88 known elements, qualitatively so very diverse, differ from one another quantitatively, namely, in the number and the position of their protons and electrons. But our point is that chemical evolution is going on, as we see in the succession or pedigree we have mentioned—uranium, protactinium, actinium, lead. It is believed that "lead" is being born in about eight different ways; and since lead does not seem to be transformable into anything else, it may be argued that there is not here much evidence of evolution.

BUT we must get rid of the idea that evolution is synonymous with progress. Evolution is the becoming of something new; and it may be something new "down," as well as something new "up." To use terms less metaphorical than "up" and "down," we may say that evolution works in the direction of increased or decreased complexity. As we have often said, the tapeworm in its inglorious lot in man's intestine is an outcome of evolution as well as the lark at heaven's gate. We say "as well as," but not "as much as," for the simple reason that evolution in the world of life is on the whole "up," that is towards differentiation or complexity of parts, and towards integration or unifying of parts. Moreover, among higher animals there is an undeniable movement towards mental qualities such as alertness, judgement, and aesthetic sensitiveness, and towards moral qualities such as sympathy and synergy—qualities which man at his best has always regarded as best. At the same time, we must remember that this movement is not the only evolution

To return, for a moment, to chemical evolution; we find abundant evidence that it is still going on, though we must admit that so far as the Earth is concerned, the trend of chemical evolution, outside of the creative chemical laboratories, is all towards simplification, towards a running down of the clocks. The synthetic chemist is a veritable creator of new complexities, some of them life-destroying like explosives, others life-saving like thyroxin against cretinism, but in terrestrial Nature the present-day transformations on the earth apart from living creatures seem to be always from the more complex towards the more simple. It is probable, however, that in the colossal laboratories of the sun and the stars, where atoms are torn to pieces and built up again, elements still unknown, more complex than uranium, may be in process of evolution. In any case it is perfectly safe to say that in so far as that process concerns chemical evolution it is very definitely going on.

ALL the cosmologists are agreed that the earth was once a fiercely hot nebulous mass which had its origin in a nebulous centre now represented by our Sun. If evolution is a change, as Herbert Spencer said, from the homogeneous to the heterogeneous, then the earth has evolved, for it acquired a crust and a core and zones between. It gained a hydrosphere and an atmosphere, and it certainly made progress in the sense that it became fit to be a home of life. Probably the word to use is development or genesis, not evolution; but the fact is certain that the earth passed through a succession of changes, and became more and more interesting as the manifestations of life upon it became more and more abundant.

> They say the solid earth whereon we tread
> In tracks of fluent heat began,
> And grew to seeming random forms,
> The seeming prey of cyclic storms,
> Till at the last arose the man.

This process of complexifying or differentiation was greatly assisted by the hand of life; thus green plants made a breathable air; in early Tertiary times grass began to cover the earth like a garment; the dainty foraminiferal shells accumulated as future chalk cliffs; and coral polyps are still building beautiful islands. Sometimes carelessly, but often beneficently, man has carved at the earth, and still he casts mountains into the sea and turns what was the desert into a fruitful garden.

It is a great intellectual gain to see our present-day earth as only one out of many successive stages on which the drama of life has been

Martin Duncan

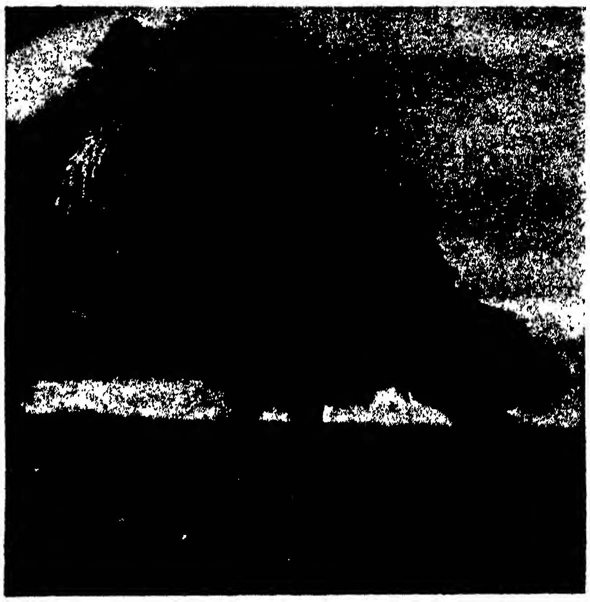
WHERE EVOLUTION SEEMS TO HALT

Evolution is not necessarily progressive as that word is usually understood, and in some cases seems to have lapsed altogether for some unknown period. The lamp-shell, for instance, has remained unaltered in its structure since the Cambrian Age.

played for untold millions of years. Tennyson had a fine vision of the evolving earth:

> There rolls the stream where grew the tree,
> O Earth, what changes hast thou seen,
> There where the long street roars hath been
> The stillness of the central sea.
>
> The hills are shadows and they flow
> From form to form and nothing stands,
> They melt like mist, the solid lands
> Like clouds they shape themselves and go.

It makes for clearness to use the term "evolution" with a prefixed adjective, for there are several different kinds of evolution which have little in common save that they are all processes of becoming, in the course of which something new emerges. Thus, as we have illustrated, there is cosmic evolution, chemical evolution, and terrestrial evolution. But our chief interest here is with none of these, nor with social evolution, but with the evolution of living creatures or organisms. How can we define this organic evolution which has led to the plant world and the animal world and ourselves? Organic evolution is a natural process of racial change in a definite direction, whereby new forms of life arise, take root and flourish, alongside of, or in place of, their ancestors, which were in most cases simpler in structure and behaviour. In cases of degeneration and parasitism the ancestors were not simpler, but the reverse. On the whole, however, organic evolution has been an advance. Life has been slowly creeping upwards. As age has succeeded age, there has been an emergence of higher types with increasing freedom and mastery. The evolutionary



Jas

BARNYARD FOWL AND ITS ORIGIN

Every one of the numerous breeds of domestic fowl, widely differe in appearance as some of them now are, is derived from the Indi jungle fowl (top). The cock and hen in the lower photograph both of a handsome Japanese stock.

MIGHTY-MOUTHED HIPPOPOTAMUS FROM THE RIVERS OF TIME

Evolution, the process of becoming, seems to have paused for an indefinite period in the case of the hippopotamus. Geologists have found from fossil remains of the Pliocene epoch that there was then a hippopotamus indistinguishable save for its greater size from the beast as we know it to-day. It was widely spread over Europe and in England wandered as far north as Yorkshire

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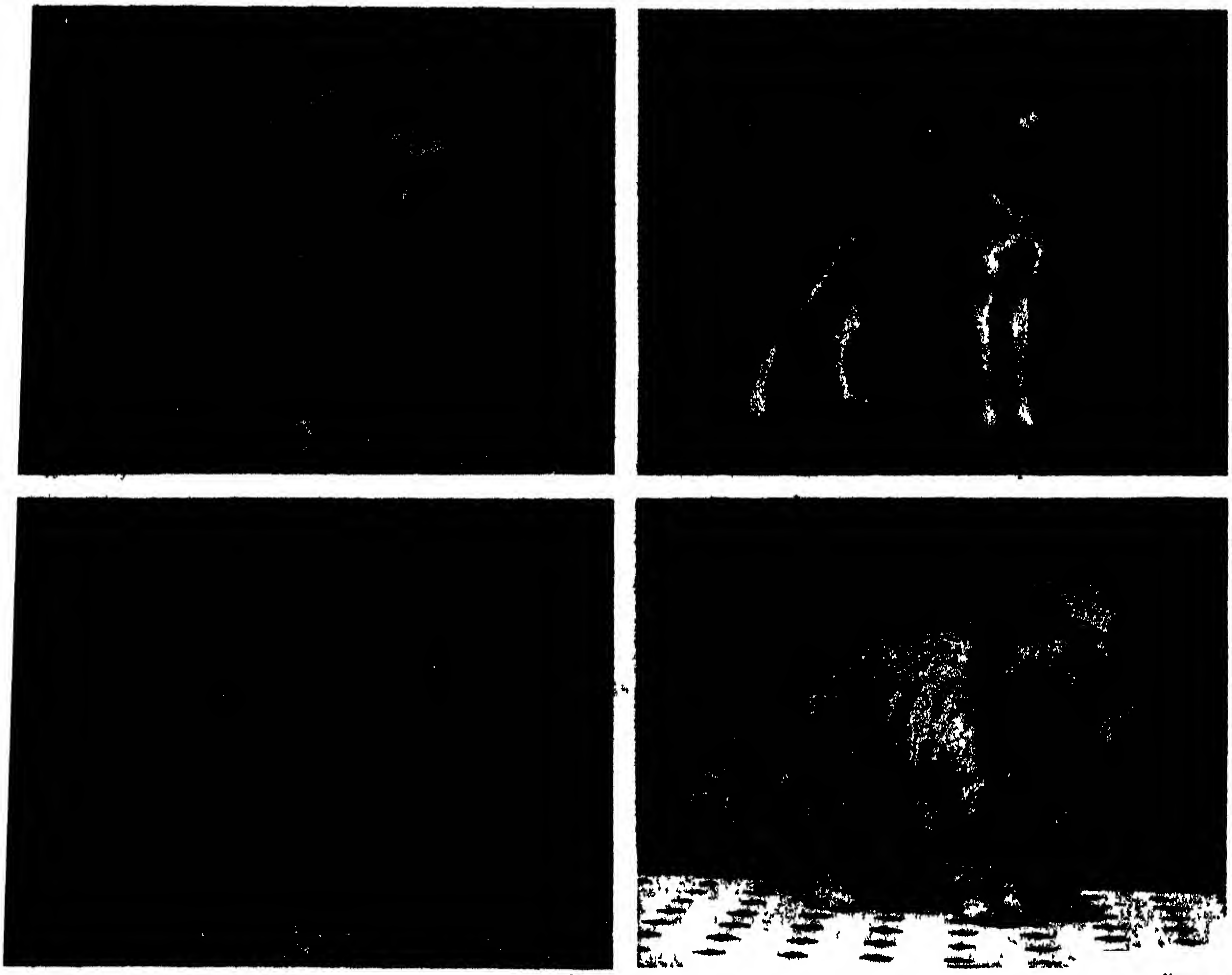


James Keystone

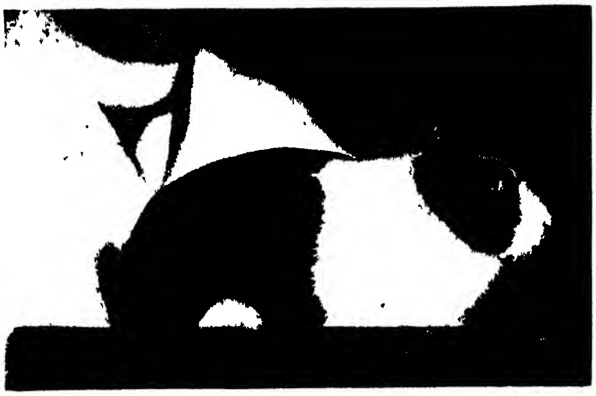
EXTRAORDINARY VARIETY EVOLVED BY MAN FROM THE STOCK OF THE WOLF

The ancestors of the common wolf and of every one of our modern breeds of dog—from mastiff to pomeranian—were the same animals. It is thought that the original tendency to such wide variation in one stock was brought about by cross-breeding in wolves of different species with perhaps an occasional admixture of jackal blood. But the original taming and handling of the wild dog remains a prehistoric mystery. Above are (top left) the Siberian wolf; (top right) Alsatian; (bottom left) Bulldog; and (bottom right) Highland terrier.

process is not necessarily progressive, but on the whole it is an advance that is revealed by the history written in the fossil-bearing rocks. If a fish does not show progress when compared with a worm, if a bird does not show progress when compared with a newt, then we must invent some other word to take the place of "progress," which admittedly had its first reference to human history.

Some organisms have certainly remained the same for ages. There are not a few conservative types which are known as ancient fossils and yet are living to-day without appreciable change in the course of millions of years. As examples may be mentioned the lamp-shell (*Lingula*) since the Cambrian Ages; the pearly nautilus, since the Cretaceous; the mud-fish, Ceratodus, since the Triassic. The New Zealand lizard Hatteria, with a pineal eye on the top of its head, is a living animal of great antiquity, the sole survivor of an otherwise extinct class of reptiles. There are many other animals which differ but little from their extinct fossil ancestors, and Darwin called them "living fossils." Perhaps there is nothing very surprising in the fact that evolution sometimes stands still, for if a creature has attained to a harmonious constitution and to a balanced adjustment to a more or less permanent condition of life, there is no reason why it should change if its environment remains the same. If novelties cropped up now and again they would be nipped in the bud. We may say, then, that in many living creatures evolution has stopped for the time being.

On the other hand, when we settle down to study living species carefully, weighing and measuring one character after another, we find that there is often great variability. Among our common birds and mammals the members of a species seem to the ordinary eye practically identical, but this is not the actual state of affairs. Many of them exhibit continual fluctuations, a little more of this and a little less of that; and these slight variations form part of the raw material of evolution. Every now and then there is something striking, like a white blackbird; but probably more important are the small variations that only the experts notice. Lotsy speaks of a collection of two



hundred specimens of buzzard (*Buteo buteo*) in the Leiden Museum, "hardly two of which are alike." The individuality of the male ruffs is famous, each an artistic unity by himself, but all the females or reeves seem to be identical.

COLOUR ALTERATIONS EVOLVED IN RABBITS

In the course of artificial breeding, where rabbits are concerned, it often happens that some of the colour factors are lost to the inheritance and such forms occur as we see above. At the bottom is a tortoise lop-eared rabbit, and (top) black and white Dutch rabbit. These types are examples of what man has helped to evolve in the animal world

The variability of living creatures is particularly conspicuous in certain unaccountable cases, where there occurs what has been called "an epidemic of variations." This is well illustrated at present by the fruit-fly, Drosophila, which has given off numerous true-breeding mutations in the course of a few years The Dutch botanist De Vries was led to recognize the frequency of mutations or brusque sports in Nature by a study of a stock of Lamarck's evening primrose (*Oenothera lamarckiana*), which he found as an escape in a potato-field near Amsterdam. It was "sporting" in an extraordinary way. Almost all its organs were varying, as if swayed by a restless internal tide. From this stock De Vries obtained, in a short time, half a dozen or more distinct varieties or elementary species, breeding true generation after generation. The evening primrose showed species in the making, and there are many other instances. Variability is a great fact of life. As Alfred Russel Wallace said: "Even Darwin did not realize how much and how universally wild species vary." The fountain of change is welling forth abundantly.

It may be said, however, that variability is all very well, but is it leading to anything? Are there any new species appearing on the earth or in the sea? Part of the answer is that many true-breeding varieties seem to be at present taking grip, like the dark-coloured sugar-birds (*Cœreba* or *Certhiola*) in certain West Indian islands, or like several dark varieties of moths in Britain.

The reason why we do not see more of these novelties is that we are so short-lived. A mutation or brusque variation may arise all of a sudden, but it may take centuries for the new strain to become a stable variety or species. The process of evolution in Nature is usually very slow. It may have taken a million years to fashion a feather, and organic evolution as a whole has probably been going on for more than five hundred million years. Yet some people expect to find the scarabee beetles of to-day different from those in the ancient tombs of Egypt. The mills of evolution grind very slowly. If the span of our life was only a few minutes we might be willing to give evidence that the small hand of a clock remains stationary.

It is sometimes said that there is no evidence of one species turning into another. In answer to this anti-evolutionist pronouncement several sets of facts must be noted. In the first place, there are fossil series, for example, of water-snails, where A and Z are very different, yet the intermediates, preserved in the strata, form a continuous gradation, just like the stages in the growth or development of an individual. In the second place, while it is part of the definition of a species that it is discontinuous—itself and no other—there are often very striking intermediate forms that link one species to its nearest relative. In the third place, the objection suggests an entirely wrong view of evolution, for it cannot be supposed that one species turns into another as if under a magician's wand. This is the error hinted at in the old word "transformism." What has usually happened is probably like this: variations arise which spread from their birthplace; as they spread they may continue varying in the same direction; they may be isolated from the originative stock by some topographical change, such as the making of a peninsula into an island; in isolation there is a tendency to inbreeding which gives stability to the new stock; intercrossing with the originative stock becomes rare, and by and by it may become impossible. The new variety—a new species in the making—does not necessarily supplant the originative species; but environmental changes may occur

which are fatal to the first species, yet favourable to the second; and so the evolution goes on. An old species does not change into a new one; a new species arises as an offshoot from an old one; and various forms of isolation help greatly.

It is part of a biological education to go to flower shows and dog shows and all sorts of similar shows. For one sees how many true-breeding races man has established in a relatively short time, and one also sees that novelties are still emerging—new roses, new chrysanthemums, new fowls and new dogs, many of them novelties to be proud of. All the races of domesticated pigeons have been derived from the wild rock dove (*Columba livia*); all the fowls from the Indian jungle fowl (*Gallus bankiva*), all the pigs from two species of wild boar, all the dogs from wolves, probably of several species and perhaps occasionally helped by crossing with jackals. How the original taming and domestication came about we can only guess, for in most cases it is a

DOMESTIC PIG AND ITS WILD ANCESTOR

From two species of wild boar all the different kinds of domestic pigs have been evolved by years of careful breeding. The fact that animal generations, for the most part, greatly exceed man's in their rate of occurrence has enabled him to control, to a great extent, the type he wished to survive. The domestic pig will survive and change just so long as man has need of it

prehistoric secret; but we know what man has continued to do. He starts from a variable animal, perhaps unusually variable because (as in dogs) the pedigree may be multiple. Variations crop up which seem to the breeder desirable; he pairs similar variants together and thus starts a strain. He continues doing three things: (1) eliminating undesirables, (2) bringing similar forms together as pairs, and (3) preventing intercrossing with other strains. A strain, confirmed by inbreeding, that is, pairing near relatives, grows into a breed; and gradually, with care, a breed becomes a reliable race, in which like usually begets like, such as collie dogs, polled-angus cattle, white leghorn fowls, marquis wheat, shirley poppies. It is not that man is a creator, for he can only operate with the variations that occur; he is rather like an artist who is supplied with fine materials which he arranges in new patterns.

With the further aid of Mendel's clue—a fundamental law of inheritance—the breeder is now able to work even more

rapidly and certainly than before, grafting one good quality after another on to a promising stock. Thus he can produce a wheat race with heavy ears, early ripening, fine flour and strong straw, to which good qualities he can add immunity to the disease called "rust." Or he can secure a race of poultry laying over two hundred eggs in a year, or a race of cows that will produce not only more milk in less time, but milk with more butter and less water. It cannot be pretended that man's sifting and breeding methods are always attended with perfect success. Hens are on the whole stupid birds, compared with the lively experimental chicks; and no one can say that ordinary sheep fulfil the promise of the adventurous lambs. But that is partly because an over-sheltered life tends to individual degeneration of wits; partly because man has selected his fowls for egg-laying qualities and palatability of flesh, not for their wits; his sheep for mutton and fleece, not for brains; and partly because he has in the course of generations consistently eliminated those hens and sheep that showed any tendency to be original and adventurous. Some of the breeds of dog that man has created seem to us undesirable and semi-pathological products, which Nature would do away with within a week. They are sometimes delicate, dull-witted, even deformed, non-viable types, which man cherishes because they please his or his customers' perverted taste. But these dysgenic products we are glad to forget when we see the large number of really fine and noble dogs. On the whole, we can say that dog breeding has been eugenic.

What has happened during the domestication of animals and the cultivation of plants is closely parallel to what has occurred in Wild Nature in the evolution of new species. Variations that crop up are sifted and separated. Changing and entailing, sifting and segregating, these are the evolutionary factors in both cases. But the part that is played by the breeder is played in Wild Nature by the various forms of the struggle for existence, helped by isolation. The reason why man can work so quickly as compared with Nature, is that he can artificially secure that similar forms pair together, and can artificially prevent cross-breeding. He can also extend his shield over small beginnings. There is no doubt that man has been a very successful evolver, and there was great force in Darwin's question: If Man has done so much in a short time, what may Nature not have done in a very long time?

Some serious students of evolution find a difficulty in the fact that man's achievements in plant and animal breeding do not always last. In some cases, but only in some, there is a harking back to the original wild type. The reason for this is interesting, and may be illustrated in connexion with the fur of rabbits.

When one looks at a wild rabbit one sees a beautiful complexity, and there are eight hereditary "factors" or "genes" that combine to produce this. In the course of artificial breeding it often happens that some of the colour-factors drop out of the inheritance—a common occurrence that cannot be explained in this chapter. If all the pigment-factors drop out in egg-cell and in sperm-cell before fertilisation occurs, then the individual young rabbit is bound to be an albino; and it may be used to start a pure-breeding white race. But if the dropping out is partial, there may be, not a pigmentless, but a yellowish, or bluish, or black or otherwise coloured offspring rabbit. If some of the cards are lost in shuffling a pack there are likely to be some very poor "hands"!

Now if the rabbits of a well-established colour-variety pair with others like themselves they breed true indefinitely; but if no care is taken, and if the pairing is promiscuous, there must be sooner or later a restoration of the original complexity of the wild rabbit; and this is called a reversion. Yet in this case it is plain that the original wild rabbit had, as regards colour, a richer inheritance than any of the domesticated varieties we have mentioned.

Disappointments with well-established breeds are often due to undesired pairing with dissimilar forms, or, in other words, to imperfect "isolation." Disappointments with new races of garden flowers may be due to cross-pollination (very difficult to avoid); or to the origin of the new strain from bud-variations which are much less reliable than seed-variations; or because the new "breed" is put on the market before it has become a stable "race."

It is certain that man has enriched the world with his races of domesticated animals and cultivated plants. In many cases he has been able to pool the good qualities of several wild species. There is no reason why this kind of amelioration should not continue for ages yet to come. But there is another kind of change which has involved losses as well as gains: man has greatly altered the numerical proportions of the plants and animals in many countries, and he has exterminated many forms of life altogether. He has naturalised many useful plants and animals in countries to which they were strangers; but, on the other hand, he has had his share in deteriorating the fauna and flora of many lands.

The number of different kinds of wild animals in Scotland has not decreased since Neolithic man settled there some eight to ten thousand years ago, but there has been a deterioration of quality. Rabbits and sparrows, earthworms and caterpillars, rats and cockroaches, crickets and bugs, are among the additions, but are a poor exchange for the reindeer and the elk, the wolf and the bear, the lynx and the beaver, the bustard and the crane, for these are among the losses. The same is true of many another country: the standard of the fauna tends to fall.

For various reasons, some of them not man's fault, many fine creatures have disappeared for ever from the Earth, creatures like the quagga, the Irish deer, and the great auk; but what man must be blamed for is the careless disturbing of the balance of Nature by short-sighted introductions, such as rabbits in Australia and sparrows in America.

Chapter XLIII

The "Wolves of the Sea"

By Herbert G. Ponting, F.R.P.S.

Author of "The Great White South"

DURING many years of travel in search of the picturesque—travel which has taken me three times round the world, and to within a few hundred miles of both Poles—it is, perhaps, scarcely surprising that interesting experiences should have come my way sufficient to fill a dozen books, and that I should have had more than one narrow escape from unconventional ways of shuffling off this mortal coil. In adventure one should not, of course, take anything too seriously, but I have always held that it is the duty of every bona fide traveller who has a real story to tell to get it into print, for it may be of interest, and even value, to his fellow creatures. Hence this account of an incident that befel me which is probably unparalleled in the annals of adventure, for I believe there is no record of a similar experience having happened to any other explorer.

Let me preface my story by stating that once—while I was a correspondent with the First Japanese Army, during the war with Russia—when I was swimming from a ship which was anchored about two miles from the shore in Fusan Bay, Korea, I was menaced by a shark, and I owed my escape to the facts that I have from boyhood been at home in the water, that I was at the time in the heyday of my strength, and that I did not lose my nerve.

But even a shark, as an antagonist in a bout in the water, is not to be compared for cunning and ferocity with some ocean fiends with which I was destined to make acquaintance a few years later, when in the Antarctic with Captain Scott, of immortal memory, during his last expedition.

THAT whales are mammals most people know, but there are many erroneous ideas current about these great creatures, one of them being that they never attack man unless themselves attacked by man. The family Cetacea, to which all whales belong, is a large one and comprises ocean mammalia ranging from the smallest porpoises and dolphins to the leviathans of the seas.

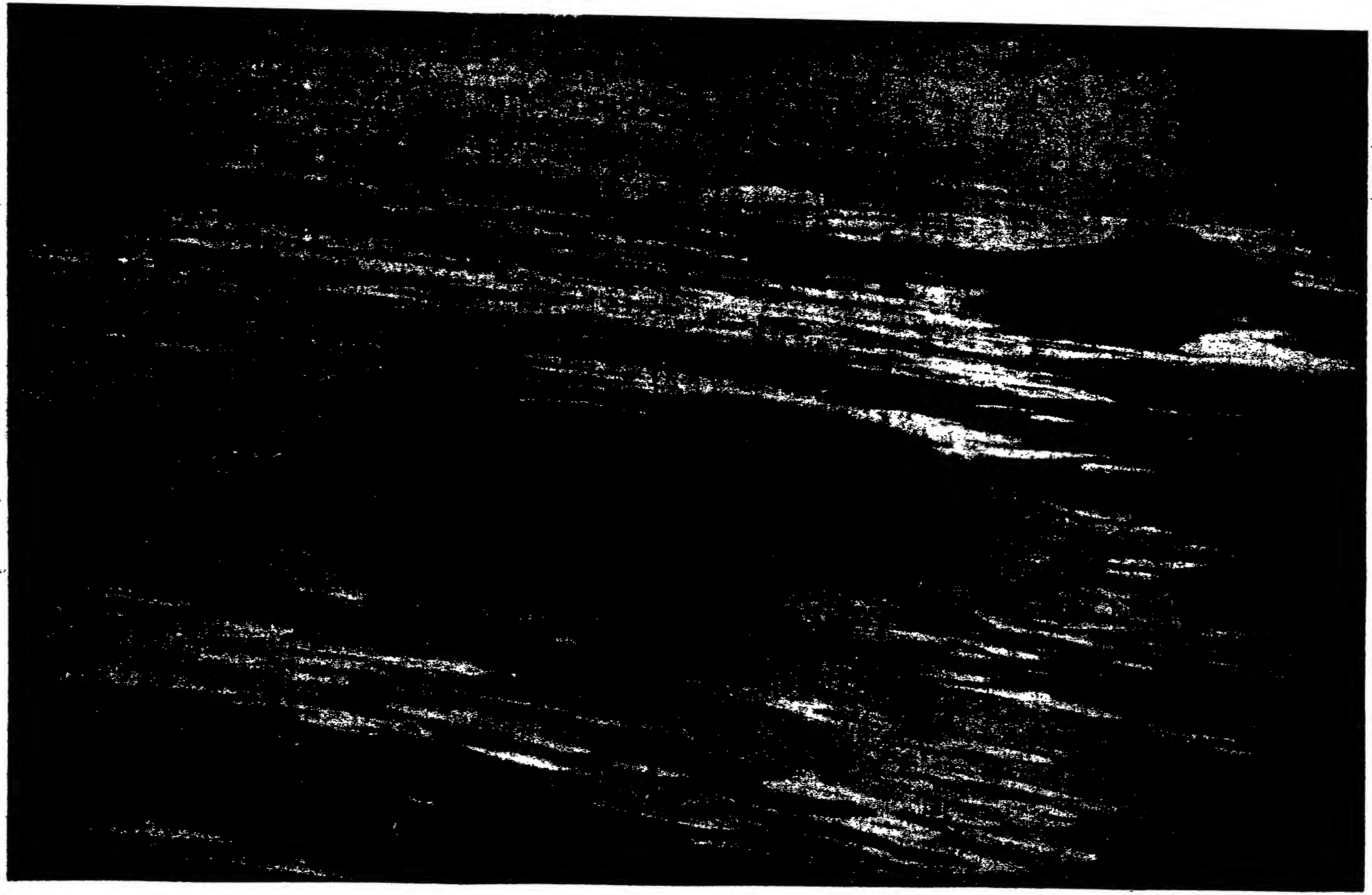
The blue whale is not only the biggest creature, so far as is known, that lives to-day, but it is probably the largest creature which has ever existed. Specimens have been killed which considerably exceed one hundred feet in length. It is one of the rorquals, or fish-eating whales, which feed by cruising open-mouthed into shoals of small fish. The right, or Greenland whale (so highly prized by the whaling men of the last century for its baleen, or whalebone), which is rapidly becoming extinct because of the ruthless manner in which it has been hunted for its valuable products, though smaller than the blue whale, is yet a colossal creature, seventy or eighty feet in length. Its food consists of enormous quantities of minute crustacea, called Euphausia (small shrimps), with which it fills its cavernous mouth, then swells its immense tongue until all water is ejected through the ragged fringe of horny baleen plates which depend from its upper jaw, and swallows down its little pipe of a throat the remaining catch.

The sperm whale which, like the right whale, is in danger of becoming extinct, and for the same reason, for it is the most valuable of all whales because of the high quality of its oil, is believed to be the largest toothed creature that has ever lived in the world. Instead of baleen plates in the *upper* jaw, as in the case of the right whale and the rorquals, the lower jaw of the sperm whale is furnished with huge teeth, more like those of a hippopotamus than of any other animal, and it preys upon the colossal octopods, or squids, which exist hundreds of fathoms deep in the sea: monster molluscs which almost equal in bulk the great cetaceans which they feed.

ENORMOUS masses of squid flesh, a cubic yard or more in size, have been found in the stomachs of sperm whales, proving that the tentacles of those ocean horrors are sixty or seventy feet from tip to tip. Incidentally, it was doubtless a sperm whale which figured so prominently in the story of Jonah's adventure during his voyage from Nineveh to Tarshish, in the time of Jeroboam, for a man might easily pass down the tunnel-like throat of a full-grown sperm whale with ample room to spare. Sperm whales frequent African coasts to this day, and three thousand years ago they may have been plentiful in the Mediterranean.

At the other end of the Cetacea family are the beautiful dolphins, which not infrequently play about the bows of ships in temperate seas. Midway between these extremes is the killer-whale, or orca, which has been well named by mariners "the wolf of the seas"—a ferocious carnivore, twenty or thirty feet in length, which preys upon seals and other warm-blooded creatures. Killer-whales also prey upon various species of their own order, even on whales much larger than themselves, which they hunt in packs, as wolves hunt the larger ruminants. When the object of attack is a full-grown rorqual, perhaps half-a-dozen times the bulk of a killer-whale, the orcas show, indeed, the cunning of wolves, for they band together and assail their prey with carefully-designed concerted action.

Two of the assassins, one on each side, seize the lower jaw of the great beast they intend to destroy, while others leap out of the sea and lash the quarry with their flukes or huge tail fins as they fall upon its back. This torturing and battering is continued until the unhappy victim becomes so weak and exhausted by the repeated blows that it



Herbert G. Ponting, F.R.P.S., Copyright

DANGEROUS KILLER WHALES: THE FIERCE WOLVES OF THE SEA

This is probably the only photograph ever taken of these great sea mammals at such close quarters—and for a very good reason. The photographer who gets as near as this to these savage and very cunning whales is risking his life. We see them coming up to blow, and the spiracle or nostril can be seen plainly in the one towards the right of the illustration. From this the breath is exhaled with the force of a blast from an air compressor, descending in a cloud of vapour. "Wolves of the sea" is an apt name for the killer whales, for they hunt in packs and destroy their prey, which is often far larger than themselves, by sheer weight of numbers, displaying a cunning and ferocity equal to that of wolves.

ON THE EDGE OF DEATH: THE AUTHOR'S ADVENTURE WITH KILLER-WHALES

While accompanying the Antarctic expedition of Captain Scott the author of this chapter saw, when the ship had been moored off Ross Island where winter quarters were to be established, eight killer whales come to the surface near by. He snatched his camera and ran to the edge of the ice. But the whales burst through the three-foot thickness of ice, leaving the photographer standing on an unstable fragment. By a seeming miracle the piece on which he stood drifted within reach of the main floe just in time, as this drawing shows.

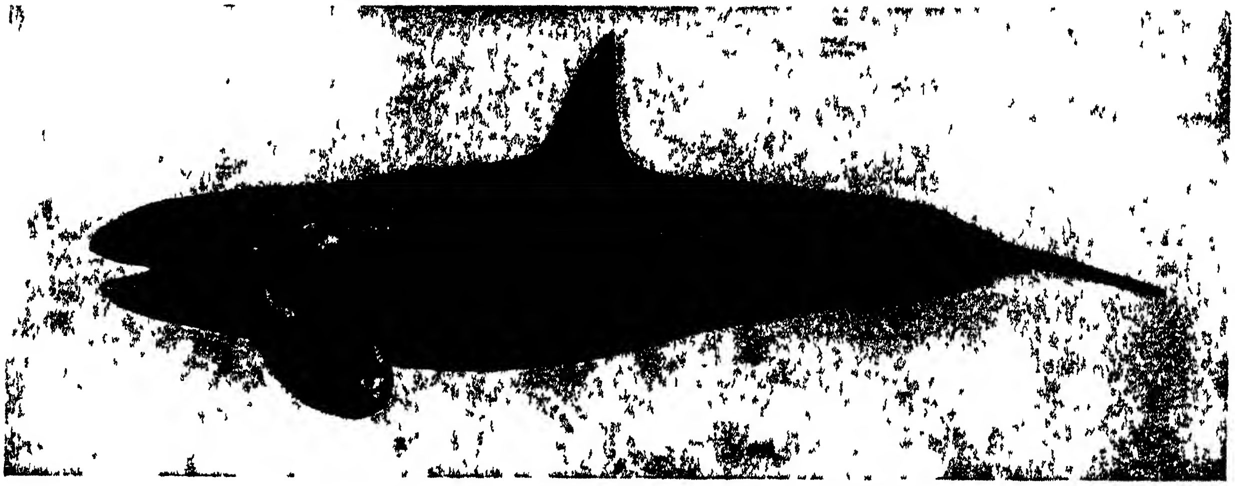
can no longer support the weight of its massive jaw. The great mandible drops, and the victorious ghouls then enter the mouth of the helpless beast and devour its tongue. Deprived of a vital organ, the dying leviathan becomes a mere derelict—and easy prey for the shoals of fish which then proceed to consume the huge carcase piecemeal.

As our expedition ship, the *Terra Nova*, approached the Great Ice Barrier—which is the largest known ice sheet in the world, and estimated to be 160,000 square miles in area, or approximately the size of France—many killer-whales rose and "spouted," as, presumably, they browsed upon the multitude of penguins that sported in the sea. The next day, soon after we moored the ship to the ice-foot off Ross Island, where we decided to build our winter quarters, I was about to start across the ice for the land with my photographic sledge, when eight killer-whales appeared near the ship, blowing loudly as they headed for a promontory of the ice, under which they eventually dived.

Hastily estimating where they would probably reappear, I snatched up my reflex camera to try to get a "shot" at them, and ran to the edge of the ice, adjusting the camera for the exposure as I did so. Just as I reached the edge, almost breathless from my rapid spurt, to my consternation the ice was suddenly heaved up under my feet and broken into fragments all about me, and the eight killer-whales, lined up fin to fin, burst from under it and blew. The head of one was within two yards of me.

I saw its spiracle open, and at such close quarters the sudden exhalation from its great lungs was like the release of a blast from an air compressor. The roar of the eight simultaneous blows was deafening in my ears, and I was enveloped in the warm vapour of the nearest "spout," which had a strong and distinctly fishy smell.

For a moment I was completely bewildered as I staggered on the raft of ice on which I was isolated, but providentially the shock sent me backwards instead of precipitating me into the sea, in which case my Antarctic experiences would have ended some-



James

KILLER-WHALE THAT HUNTS THE SEAS IN PACKS

Even such whales as the rorquals, some of which may be over eighty feet long, are not immune from the ruthless killer whale, which is only from twenty to thirty feet long. The secret of its success is that it hunts in packs. Two killers will open the attack on the rorqual, one on either side, and seize its lower jaw. The rest leap out of the sea and fall on the rorqual's back, lashing with their tails until the great beast is tired out and its jaw drops. Then the killers enter its mouth and bite out the tongue. Above is a museum specimen.

what prematurely. As the whales rose from under the ice there was "a loud booming sound," to use the expression of Captain Scott, who was a witness of the incident, as they struck and broke the ice, which was about a yard thick, with their backs. The instant they had cleared it, with rapid swings of their flukes they made such a commotion in the water that the floe on which I stood was rocked so violently that it was all I could do to keep from being thrown into the sea.

Then the eight whales turned about and deliberately attacked me. The ship was not a hundred yards away, and Captain Scott and all my shipmates were watching, transfixed with horror, for, as they told me afterwards, they expected every moment to see me fall into the open jaws of one of the eight furies that were now pushing their heads out of the sea in the endeavour to get me. I heard frantic shouts of: "Jump, man, jump! Be quick! Look out! Run, for God's sake!"

But I could not run, as the ice was broken up for forty yards around me. I was hard pressed to keep my feet as, hampered with a large reflex camera, which I would not have lost for anything, I made my way from piece to piece of the broken ice, with the whales close at my heels, snorting and making a horrible noise as they turned over the floes behind me. I recollect distinctly wondering if I should reach safety or would the whales get me; and how very unpleasant the first bite would feel, but that it would not matter much about the second. The broken floes were drifting in the current, and as I reached the one nearest the firm ice, I thought my number was up, for the leap was so wide that had I attempted to jump it I should inevitably have gone into the water. More frenzied shouts from the ship. "Jump, man, jump quick!" But jump I absolutely dare not.

Then a miracle happened. Either the commotion made by the whales, or else the current caused the ice floe on which I stood to drift nearer the firm ice, and I leaped to safety, not, however, a moment too soon, for, looking back as I fled I saw a huge black and tawny head rise out of the sea at the very spot where I had leapt, and it rested on the ice-edge, looking with little glistening eyes to see what had become of me. The great jaws opened wide, and I saw the terrible teeth I had so narrowly escaped. One after another the sinister heads shot up through the cracks to a height of seven or eight feet, all showing fearful teeth. But I was safe, and I ran until I was out of all further danger. Captain Scott met me. He was deathly pale as he grasped my hand and said: "Thank God, you are safe! That was the nearest squeak I ever saw!"

In his account of this incident in his journal, Captain Scott wrote: "Of course, we have known all along that killer-whales continually skirt the edge of the ice floes and that they would undoubtedly snap up anyone who was unfortunate enough to fall into the water; but the fact that they could display such deliberate cunning, and that they were able to break ice of such thickness, and that they could act in unison, was a revelation to us."

The picture which illustrates this adventure is not, of course, a photograph. It has been drawn from my own desciption of the incident, from that of Captain Scott, from my photographs of the surrounding landmarks, and from personal study of the models of killer-whales in the Natural History Museum at South Kensington, London.

END OF FIRST VOLUME